

There are three popular single-user operating systems which are available on a range of machines. Other systems, such as Apple DOS and TRS-DOS are restricted to a single machine or manufacturer.

The CP/M family of operating systems is available for both 8- and 16-bit machines, and achieved a tremendous degree of success in the years before it was supplanted by the MS-DOS family from Microsoft, which includes the IBM PC-DOS. However, the recent variants, such as Concurrent DOS 386, offer a viable alternative in many situations.

However, MS-DOS seems likely to continue to be the dominant single-user operating system, until around 1990 when OS/2 will take over. OS/2 offers multitasking and more sophisticated networking and graphics support.

## CP/M and Derivatives

The first real operating system for microcomputers was CP/M (Control Program for Microcomputers), which was for a long time the dominant operating system with over two million legitimate installations and probably nearer three million including pirates. It is of decreasing importance to PC support staff, as most machines which use it are now being retired, and it is mainly of historical interest, and included in the notes for reference.

CP/M was originally written as a spare time project by Gary Kildall as a replacement for paper tape loading of engineering development system software. When Intel Corporation declined to use the system, Kildall licensed the system to Lawrence Livermore Labs, who used it to control nodes in an early network system.

It was then picked up by IMSAI, manufacturers of the second microcomputer, and sold as IMDOS, then Cromemco used it. Version 1.3 appeared as an end-user product, installable by the purchaser, in 1977, at a price of \$US70.

## CP/M 2.2

CP/M started life as an engineer's software development system to replace timeshared cross-assembler utilities for microprocessors. To this background can be attributed the system's vaunted user-unfriendliness.

Early versions of CP/M were closely tied to particular hardware configurations; however, from version 1.4 on, CP/M was split into five distinct areas, only one of which is machine dependent.

The BIOS is the Basic Input Output System, which contains all hardware dependent code to interface with the floppy disk controller, console, etc.

The BDOS is the Basic Disk Operating System, which contains the file management system kernel, and is machine independent.

The CCP is the Console Command Processor, which is loaded at warm starts to interpret the command line typed by the user at the console. The CCP can be overlaid by application programs.

The TPA (Transient Program Area) is where programs are loaded and executed. Transient programs can overlay the CCP, since its functions are not needed by running programs, and they can also overlay the BDOS, provided they do not require its file system services.

The Base Page area contains interrupt vectors, certain key variables and vectors to the BDOS and BIOS. Notice that CP/M itself resides at the top end of memory and extends downwards.

The CCP provides a number of resident commands:

TYPE - list a file at the console

DIR - display the disk directory of files

ERA - erase a file or group of files

REN - rename a file

USER - move to a different user area

SAVE - save the contents of the TPA to disk for debugging

The remaining utilities take the form of transient programs which are loaded from disk when required:

ASM - assembler

LOAD - loader

DDT - Dynamic Debugging Tool

ED - line oriented editor

PIP - file copy program

STAT - disk status and statistics (free space, etc.)

DUMP - simple file hex dump

SUBMIT - batch command

XSUB - SUBMIT extension

Generally, at least two hardware dependent programs are supplied by the computer vendor:

FORMAT - Formats a blank disk

SYSGEN - Transfers the operating system between disks and memory

Digital Research, the authors of CP/M, also offer a number of upgraded utilities for CP/M:

MAC - macro assembler

RMAC - relocating macro assembler

LINK - linking loader (linkage editor)

LIB - relocatable module librarian

XREF - cross reference lister

SID - Symbolic Interactive Debugger

ZSID - As above, for Z-80 code

TEX - text formatter

### File Naming Conventions

d:filename.typ

d = optional disk drive name

filename = 1 to 8 character file name

typ = 1 to 3 character file type

Typically 64, 128 or 256 directory entries are supported per disk, depending on the disk size. Hard disks will have 768 or more directory entries. Each file requires one directory entry, though large files will require more.

### CP/M Plus (CP/M 3.0)

CP/M Plus brings the bank selection and file system features of MP/M II (see below) to the single-user environment. This version of CP/M is able to manage additional banks of memory in "which it can store the disk directory and track buffers to achieve significantly faster disk accesses (tests indicate up to seven times improvement in accessing indexed files).

CP/M Plus also supports a real time clock, permitting data and time stamping of files, as well as password protection, although this consumes disk directory entries.

CP/M Plus supports customisable extensions to the operating system called Resident System Extensions (RSX). This allows additional functions to be added to the operating system and called from user programs in the same way as regular system calls. An example of an RSX is the GSX (Graphics System Extension) ANSI standard graphics driver.

The RMAC macro assembler and SID debugger are supplied as standard with CP/M Plus, since it is customised in a different way. CP/M Plus is rather more user-friendly than 2.2, in that the user no longer needs to type control-C when changing disks, and the system also provides input-output redirection, though in a less sophisticated manner than UNIX.

### *CP/M Plus Built-in Commands*

DIR - displays non-system file directory

DIRSYS - displays a system file directory

ERASE - erases a file or group of files

RENAME - renames a file

TYPE - displays an ASCII file at the console (can page output)

USER - moves to a different user number

### *CP/M Plus Transient Programs*

COPYSYS - copies the system tracks to a new diskette

DATE - sets or displays the current system date

DEVICE - assigns logical devices to one or more physical devices, changes device driver protocol and baud rates or sets console screen size

DUMP - ASCII and hex dump

ED - line oriented editor

GET - directs input from a disk file rather than console

HELP - user assistance

HEXCOM - program loader

INITDIR - initialises a diskette directory for date/time stamping

LINK - linking loader

MAC - macro assembler

PIP - file transfer program

PUT - redirects output to a disk file

RMAC - relocating macro assembler

SET - controls file system options such as date/time stamping, disk labelling and password protection

SETDEF - sets system options such as the file search path

SHOW - displays disk status and statistics

SID - symbolic interactive debugger

SUBMIT - batch operation utility

XREF - cross reference lister

Some observers take the position that CP/M Plus is 'too little, too late'. I simply suggest that you try telling that to the owner of a CP/M Plus system. They are all very enthusiastic.

CP/M-86

CP/M-86 provides a similar level of functionality to CP/M 2.2, but on the Intel 8086 and 8088 16-bit processors. These use segmentation techniques to manage multiple 64 Kbyte areas of memory, and the processor architecture is upward compatible with the 8-bit processors, so that there is a conversion path for existing eight-bit software.

CP/M-86 provides a number of additional functions over CP/M 2.2; in particular, the ability to have multiple programs co-resident in memory (although not executing concurrently), together with memory allocation functions.

Unlike CP/M 2.2, CP/M-86 lives at the bottom end of memory and grows upwards; it also supports relocation of programs at run-time.

### Concurrent CP/M 2.1

Concurrent CP/M is a single-user implementation of the MP/M-86 real-time kernel on machines which have integrated screens, such as the IBM PC, Apricot, DEC Rainbow, NEC APC, etc. It allows the user to run up to four programs simultaneously, each program occupying a 'virtual console'. By striking the control key together with the keys of the numeric pad, the user can switch between consoles.

It also supports the file date and time stamping, password protection and other file features of the multi-user systems.

### Concurrent CP/M 3.1

This release implements the CP/M Plus file system, so that there is no longer any need to type control-C when changing disks. It also brings cache buffering, hashed directory access and other high performance features. As the replacement for MP/M-86, Concurrent CP/M 3.1 is being released on a number of multi-user systems, although it is most visible on the IBM PC, implemented as a single-user multi-tasking operating system.

### Concurrent CP/M 3.1 with Windows

Concurrent CP/M is an interesting new twist in the operating system market. From a cynical viewpoint, it is possible to view it as a shallow attempt by DRI to score off Microsoft by implementing the DRI multitasking technology in the IBM PC marketplace. Or is it a genuine leap forward?

I tend towards the latter view. CCP/M is not merely single-user MP/M on an IBM PC; it really is a new technology. Here are the major features: you can run up to four programs at once, with instant switching between programs using the control key and numeric keypad. Each program outputs to its own display, which can be a separate 'virtual console' or one of several overlapping windows on the main screen. There's no need to hit control-C when changing disks any more. And file operations are considerably faster.

Concurrent CP/M uses the real-time multitasking kernel of MP/M to support multiple programs (they're called tasks or processes once they've loaded) at one time. However, while the system supervisor and scheduler are similar, that's about the limit of the resemblance.

The new operating system implements what DRI call the 3.1 file system, as used in CP/M Plus (remember the dBASE performance of the Morrow MD-11). This automatically logs in switched disks, and more importantly is very much faster at locating files, particularly on hard disks.

But perhaps the major benefit of the new system is its 'windowing' capability (which was first displayed and shipped a week after the announcement of Microsoft Windows, much to that company's chagrin). Up to four windows can be displayed at the same time, and using the 'WMENU' window manager, they can be moved around the screen, resized, blown up to fill the screen and otherwise manipulated. Striking the control key plus 1, 2, 3 or 4 on the numeric keypad selects the appropriate window and moves it to the front of the pile.

Within windows, applications behave much as they do under conventional CP/M. However, the window system supports cut and paste capability for applications that can make use of it, and the GSX (Graphics System eXtension) system supplied as part of CCP/M supports a mouse driver for the Mouse Systems Mouse, making applications such as DR Graph mouse driven.

Windows can be set up by the user in two ways. The WINDOW command accepts a great long list of parameters on the command line, and if they're all right, it instantly resizes, recolours or moves the specified window. However, a more useful way of manipulating windows is through the WMENU window manager. Once this is loaded into memory, it resides there permanently as indicated by the legend 'Win' in the CCP/M status line at the bottom of the screen.

Wmenu is invoked by pressing the control and plus keys at the same time. The 25th line now becomes a Lotus-like menu of commands for manipulating the windows. The user can reposition them, re-size them, control scrolling within them, set foreground

and background colours and automatically write out SUBMIT files using the WINDOW command to set them up.

At any time, windows can be blown up to fill the screen or shrunk to a small area to allow monitoring of activities. Most users, however, will simply use CCP/M to run multiple programs with only one program actually in use at one time; the productivity benefits of CCP/M come from being able to switch between tasks in response to unscheduled interruptions such as phone calls.

We've tried a number of applications and utilities under CCP/M, with no difficulties at all. dBASE needs to be installed for MP/M operation, but that's no problem, and WordStar works just fine, as did the various utilities we shunted across from our MP/M system.

There are a few minor deficiencies in the system. First of all, there is no system status program - equivalent to MPMSTAT - to advise the user what programs are running; on the other hand, a lot of that information is available from the 25th line status displays anyway. Nor is there a copy of DDT86, ASM86 or any other technical utilities; CCP/M is very much an end-user product. A Programmer's Pack is available at extra cost, as the typical user is never going to write his own assembly language programs.

A forthcoming enhancement to Concurrent CP/M, called Concurrent DOS, adds the ability to run IBM PC DOS programs under Concurrent CP/M. The system automatically senses disk formats, and maps DOS system calls into CCP/M calls. The DOS 1.0 calls are all supported, as are most of DOS 2.0. Some DOS 2.0 facilities, such as handles, 'pipelining' and the hierarchical file system do not fit well with CP/M's design philosophy, but Concurrent DOS makes a plausible attempt at translating them anyway - for example, translating hierarchical directories into user areas.

DRI's avowed intentions is to support the 20 most popular DOS applications under Concurrent DOS, so that programs such as Lotus 1-2-3 and others will work fine. When implemented on non- IBM hardware, Concurrent DOS provides MS-DOS support, with all the hardware dependence that implies.

Although Concurrent DOS provides a subset of DOS 2.0 commands, DRI are known to be working on a further version, called V4, which will bring it up to the DOS 2.1 level.

### Concurrent PC DOS 3.2

Concurrent CP/M has given birth to a successor: Concurrent PC DOS. Realising that the vast majority of IBM PC software packages are designed to run under PC DOS, Digital Research has set out to provide a means of running this software under Concurrent CP/M. The result is Concurrent PC DOS version 3.2, a new operating system which can run both CP/M and PC DOS programs.

Concurrent PC DOS can sense whether a disk is in CP/M or DOS format, and read and write appropriately. It can also distinguish between .COM, .EXE and .CMD files, and responds to the different sets of operating system calls appropriately. The result of all this is that, as far as the user is concerned, he can simply insert a disk and run the programs with no concern about which operating system to use.

Well, almost. Some programs - particularly those which are on copy-protected disks - will not run. Those which address the DOS buffers directly will not find them, and programs which use the DOS 2.0 file handles will also run into difficulties. But the good news is that this version of Concurrent PC DOS recognises and uses hierarchical directories.

Digital Research has stated its intention of supporting the top twenty most popular PC applications, such as Lotus 1-2-3, dBASE II and others.

Concurrent comes with a number of utilities, most of them versions of programs previously sold by other companies. For example, ED is gone (Hooray!). In its place is DR-EDIX, a full- screen with much more sophisticated capabilities and much more useful to the average (particularly first-time) user.

For the user who wants some simple database capabilities, DR-CardFile allows the creation of simple files which can be searched and scrolled through, rather like a Rolodex. And since communications is increasingly important today, the package is supplied with DR-Talk, a modem communications program which bears a suspicious resemblance to PC-Talk.

A program called File Manager allows the user to clean up disks by moving files around, deleting them and backing up, all through a menu-driven user interface. In fact, this is the major difference between Concurrent DOS and PC DOS, from the user's point of view: most of the Concurrent Utilities are menu driven and make heavy use of the PC function keys.

All of these utilities are a cut above the usual standard utilities supplied with PC operating systems in the past. But Concurrent still has further tricks up its sleeve.

A common requirement is to just have a quick look at a file while someone else is using the machine. On conventional single-

tasking operating systems, this means that they have to interrupt their work, close all files and give up their seat while you zip and and check something, then resume again. With Concurrent DOS, this is not necessary, as a second terminal can be attached and used at the same time as someone else is working at the main screen. Of course, this second terminal will not support graphics, but it will run WordStar or dBASE quite happily.

In many other ways, Concurrent is quite similar to PC DOS; for example, there's an AUTOEXEC.BAT file which is executed upon "startup. SUBMIT has gone, replaced by BATCH, which is automatically invoked when required to run batch files.

Concurrent DOS is really not suitable for use on floppy-only systems; many of the commands which were built-in in earlier versions of CP/M and DOS (like TYPE) are now programs, and these have to be on-line virtually all the time. In addition, if you want to run four programs at a time, you will generally need to have overlay files or screen files available, and this is just not possible with floppies only.

#### Concurrent DOS 4.1

Concurrent DOS 4.1 has extended the functionality of the earlier releases to provide compatibility with MS DOS version 2. It now supports subdirectories, is considerably faster and is generally more familiar to the DOS user.

#### Concurrent DOS XM (5.0)

Concurrent PC DOS XM (Version 5.0) moves further away from the old CP/M environment and towards the DOS commands and user interface. However, the major breakthrough is in memory management. Concurrent DOS XM is able to take advantage of enhanced expanded memory cards such as those produced by QuadRAM and AST Research by using a bank switching technique to overcome the 640 Kbyte memory limitation for user programs. By making the bottom 256 Kbytes of memory global and using it as the permanent base of the operating system, and switching in and out multiple 384 Kbyte applications pages, Concurrent XM is able to run multiple large applications.

As with earlier releases, it is able to support external terminals for multi-user operation, and incorporates a user-modifiable menu system. Commands such as DSKMAINT have gone, replaced by FORMAT, BACKREST is replaced by BACKUP and RESTORE, and other commands like CHKDSK and TREE have appeared for the first time.

Concurrent XM is very much more DOS-like, and is able to support the majority of reasonably-behaved DOS applications.

#### Concurrent PC DOS 6.0

This is an almost complete rewrite of Concurrent DOS. While earlier versions were really Concurrent CP/M with the added ability to run DOS software, Concurrent 6.0 is really a Concurrent version of DOS with the ability (increasingly irrelevant) to run CP/M-86 software. It is almost completely compatible with DOS 3.3, including the ability to manage Extended DOS Partitions.

#### Concurrent PC DOS 386 V 2.0

This is an implementation of CPCDOS 6.0 which uses the 80386 processor's ability to create multiple 8086 virtual machines. It is available in single user, 10-user and 25-user versions, and is able to run DOS programs such as Lotus 1-2-3 on external terminals.

#### CP/M-68K

This is a version of CP/M for the 68000 processor. It runs on Sord, Compupro, Sage and other hardware, but on most systems, the user will notice very little performance difference over CP/M 2.2 systems. However, the system implementer will see a major difference - the system, including the BIOS portion, is implemented in C. The system is therefore supplied with both a C compiler (no floats) and a 68000 assembler.

#### Personal CP/M

This is a scaled-down version of CP/M in ROM to meet the requirements of the Japanese home computer market. It has also been released in Europe.

The multi-user operating system area is also the scene of bloody battles at present. Digital Research entered the field with multi-user multi-tasking versions of CP/M, together with a networking system kernel, but the first eight-bit version of MP/M suffered major problems and the network system never caught on.

A number of other suppliers have offered proprietary operating systems, but were unable to take advantage of the base of CP/M applications software. Others boasted CP/M compatibility, but invariably there are popular programs that these systems will not run.

The major hope for the future is UNIX and its derivatives. It is portable and relatively easy to install, but so far has not been widely offered to the commercial market.

## MP/M II

This is the 8-bit multi-user equivalent of [CP/M](#). It offers broadly similar facilities, with the addition of larger files, password protection on filenames, and of course, multi-tasking capability.

While MP/M can be used in a single bank of 64K (or even less) of memory, this leaves insufficient space for large applications programs. Generally, therefore, it is used with bank selection circuitry, which breaks the memory of the computer into multiple 48 Kbyte banks plus a 16 Kbyte common bank at the top of memory which contains the operating system and common storage.

MP/M (like virtually all multi-user operating systems) is basically unsuitable for use without a hard disk. In addition, while the 8-bit second generation processors can provide adequate performance for a single user, with multiple users running commercial software, the performance becomes noticeably slower than a single-user system.

Maximum file size is 32 Mbytes, and files can be date and time stamped on creation and update. In addition, password protection is supported through the addition of a semicolon and eight-letter password to filenames, thus:

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d:filename.typ;password
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Note that while this facility is supported from the command line, most languages do not support passwords on files opened from within programs.

In general, tasks which are very I/O bound - such as word processors - will run in shared systems with little degradation, while CPU-intensive programs - such as number-crunchers - will split the processor between them and degrade linearly with the number of processes on the system. Disk contention can also play havoc with such systems.

On the plus side, MP/M II was well designed with file and record locking, as well as interprocess protection mechanisms. It's all a tight squeeze into an eight-bit machine, but I have seen one or two very good implementations.

## CP/Net

MP/M II and [CP/M](#) systems can be clustered into a network which allows the [CP/M](#) slaves to utilise resources attached to the MP/M system server. The CP/Net software package consists of a machine-independent Network Operating System and a user-customisable Network Input/Output System, together with some associated utilities.

### *CP/Net and DR/Net Slave Commands*

LOGIN - log in to the specified master

LOGOFF - log off from the specified master

SNDMAIL - send mail to another slave or master

RCVMAIL - Receive mail

NETWORK - Enables slave to assign selected I/O to network

LOCAL - reassign I/O back to local

ENDLIST - sends end-of-file character to list device

DSKRESET - resets the specified drive for media change

CPNETLDR - load the CP/NOS

CPNETSYS - displays the slave configuration table

### *CP/Net and DR/Net Master Commands*

BROADCAST - Broadcast mail to all slaves currently logged in

MRCVMAIL - receive mail

MSNDMAIL- send mail to another slave or master

SPOOL - spool list files to the printer and optionally delete them

Released at the same time as CP/M 2.2 and MP/M 1, CP/Net never caught on, simply because it took up too much room in memory and the user could not run most programs as a result. It has subsequently been replaced by DR/Net.

#### MP/M-86

While MP/M-86 shares a heritage with the other members of the CP/M family, it is generally a more sophisticated product. It seems to be rather more optimised for multi-user operation, and many of the commands have been extended; for example, RENAME can rename multiple files at once.

While MP/M-86 can support up to 16 users, current hardware limitations mean that eight is a reasonable limit, though more are feasible for enquiry-oriented applications. MP/M-86 is gradually being replaced by Concurrent CP/M (see above).

DRI supply the source code to the system 'shell', and several vendors have taken the opportunity to enhance this with user logon passwords, user time accounting and the like.

#### MP/M-8/16

MP/M-8/16 is a proprietary modified version of MP/M-86 designed to operate on Compupro hardware using their dual processor CPU card. This allows concurrent execution of both MP/M-86 and CP/M-80 software. In addition, the TMP (Terminal Message Processor - equivalent to the CCP) has been extended to provide user id and password logon, user time accounting and other features. The result is a good general-purpose commercial operating system.

#### DR Net

This is the new networking system from Digital Research. Running under Concurrent CP/M it extends the password protection schemes of that operating system across the network. Machines can be mixed; the prototype at Digital Research used Compupro systems mixed with IBM PC's. Gifford Systems have had a network running for several months which comprises fourteen computers (13 multi-user and 1 PC XT), with 463 Mbytes of disk storage and fifteen printers. Any user can log into any disk drive and print on any printer - subject to security constraints.

The network is not restricted to any particular kind of hardware, although early systems have been implemented using ARCNet hardware and Ethernet.

#### OASIS

OASIS is available in both 8- and 16-bit versions for the Z-80, 8086, Z-8000 and 68000 families of processors. It offers features such as user time accounting and password protection which are necessary for commercial applications.

OASIS offers a number of languages for applications development, including a re-entrant BASIC interpreter/compiler pair which minimise memory requirements. Also available are a C compiler, COBOL, relational database and word processing system. However, OASIS lacks the wide software base which the CP/M family enjoy.

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