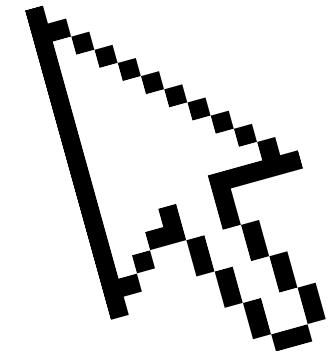


# OS/2



A case study by:

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# IBM OS/2

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## INTRODUCTION:

OS/2, developed as an alternative to MS-DOS, was developed by a team of programmers from Microsoft and IBM, with Microsoft doing most of the programming. It was designed to be shipped with the IBM PS/2 (Personal System 2) as an alternative to MS-DOS and Windows. Having better features like voice recognition and inbuilt support for Java.

In 1991, after four years of development, Microsoft and IBM decided to stop the partnership, with Microsoft putting up Windows as a direct competitor. The last major update, OS/2 Warp 4.52, was released in 2001 and support was plugged in the year 2006. The project has since been sold to other companies.

## INSTALLATION:

NOTE: The final release, OS/2 Warp 4.52, which is being installed, comes with driver files needed to run it on a generic computer. Installing earlier versions will require extra patching.

## REQUIREMENTS:

- i) OS/2 boot CD
- ii) OS/2 client CD
- iii) Suitably setup Virtual Machine

→ The boot CD and client CDs are available for download from several websites. Out of these, the images used today have been sourced from

<https://winworldpc.com>

→ In Virtualbox, to install OS/2, a special machine configuration is already available. In the create new machine window, the 'IBM OS/2' option is available in the drop down menu.

→ On selecting OS/2 Warp 4.5 in the Version dropdown and clicking Next, Virtualbox suggests RAM as 128 MB, and a 2 GB system hard drive.

(hard time 14 minutes)

The specifications are as follows:

Type: IBM OS/2

Version: OS/2 Warp 4.5

RAM : 256 MB (for better support)

Chipset: P11X3 (southbridge - emulated)

Processor: 1 (1 thread out of 12 possible threads)

VRAM : 5 MB

Storage: 2 GB IDE hard disk

→ To begin installing, choose the OS/2 boot disk image in the storage dropdown and start the machine.

→ The VM boots off the selected disk and displays a prompt to insert the OS/2 Warp CD-ROM. (Figure 2)

→ At this point, from the storage dropdown, choose the OS/2 Warp client CD and in the VM, press Enter. (use right ctrl (host key) to switch between VM and host).

→ This begins the installation and displays the initial Welcome page, Agreements page etc which can all be skipped by pressing Enter.

→ On the page issuing a warning about minimum disk size (120 MB) press Enter and this drops users in the Disk formatting tool.

→ Press F5 here to see the physical disks, choose the 2GB IDE disk attached, press Enter to create a new bootable volume, choose the drive letter (C:11) and press Enter. Assign the drive a name.

→ After this press F3, choose 'Save the changes and exit' and reboot the device, following the same two disc procedure as earlier.

→ On rebooting and going through the welcome screens again, we get to the disk selection process, where the newly created disk partition has to be chosen. Installation starts here with file copying.

→ The installer now switches to graphical mode, displaying options for applications and features and device settings. Change the 'Country/Region' option and use the defaults for everything else.

→ In the following screens, choose the required software features, additional applications, set the hostname and domain name (all capital), user name and password. If intending to use the Internet, follow the next step or leave at default and press Next. This completes the install process.

→ To make the internet work, remove default network device, choose 'AMD PCNet Ethernet Adapter', set protocol to 'TCP/IP'.

# OS/2 Installation

Created	@Feb 8, 2021 11:14 PM
Roll number:	CB.EN.U4CSE19038

**Boot screen:**



Figure 1: The boot screen for OS/2 Warp 4.52

**Disc change:**

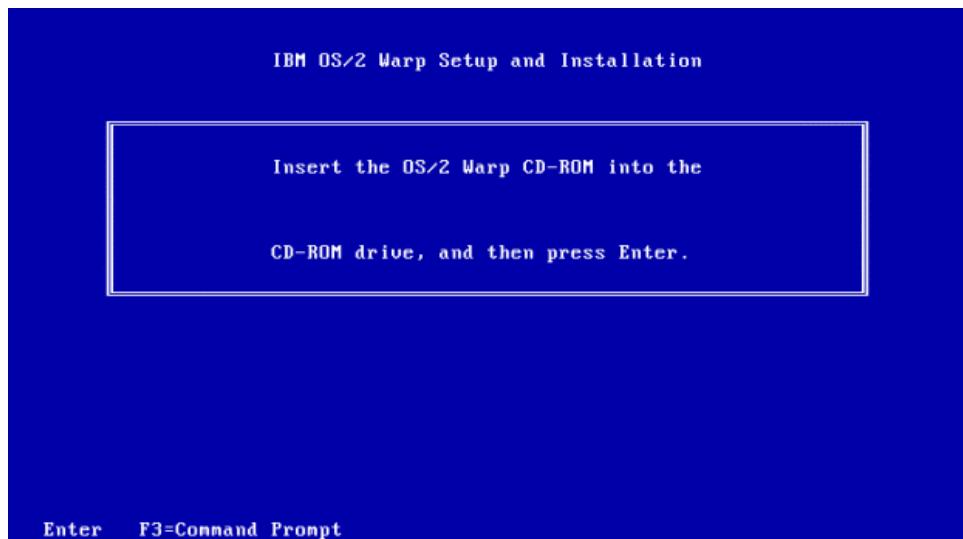


Figure 2: Once booted with the boot image, boot files are copied to RAM, and the client CD is inserted to continue the installation.

## Welcome screen:

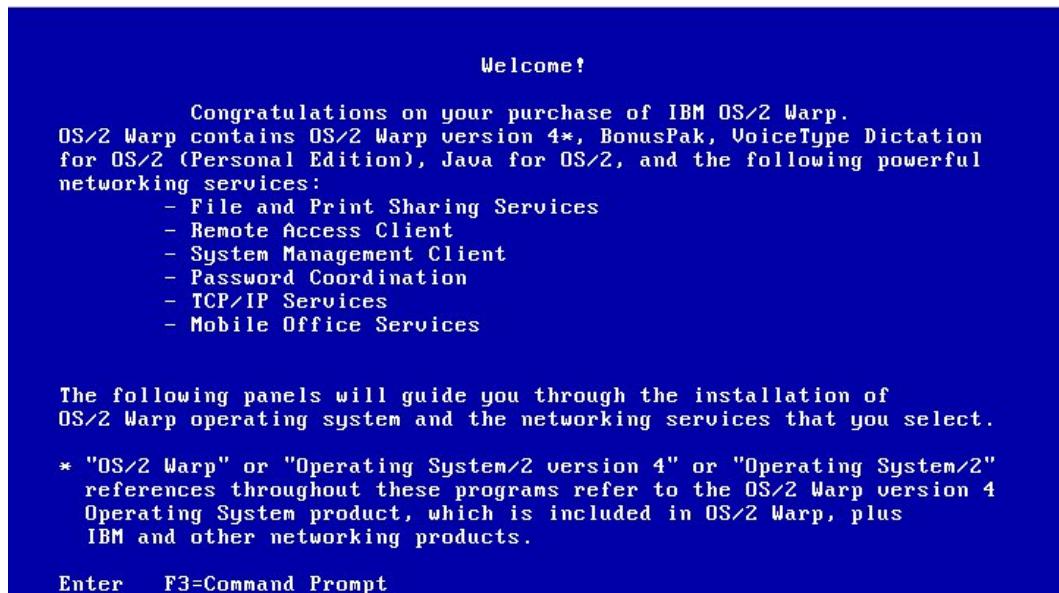


Figure 3: Welcome screen listing features

## Disk Partition Tool

Logical Volume Management Tool - Logical View				
Logical Volume	Type	Status	File System	Size (MB)
[ CDROM 1 ]	*->C: Compatibility		CDFS	513
Disk Partition	Size (MB)		Disk Name	

F1=help F3=exit F5=Physical View Enter=Options Tab=Window

Figure 4: Logical Volume Management Tool in the logical view - before creating the new partition

## Partitioning new disk

Logical Volume Management Tool - Physical View				
	Size (MB)	Free Space:	Total	Largest
Use existing partition				
Allocate from free space	4400	4400	4400	4400
Ch				
[ free space 1 ]	4400			
Enter a name for the partition: [ A ]				
Enter a size for the partition: 4400				
Disk Partition	Size (MB)	Type	Status	Logical Volume
[ free space 1 ]	4400			
 Enter the partition size in megabytes				

F1=help

Figure 5: Creating a new logical volume from the device view - displayed after clicking F5 in the LVM Tool

## Installing - copying files

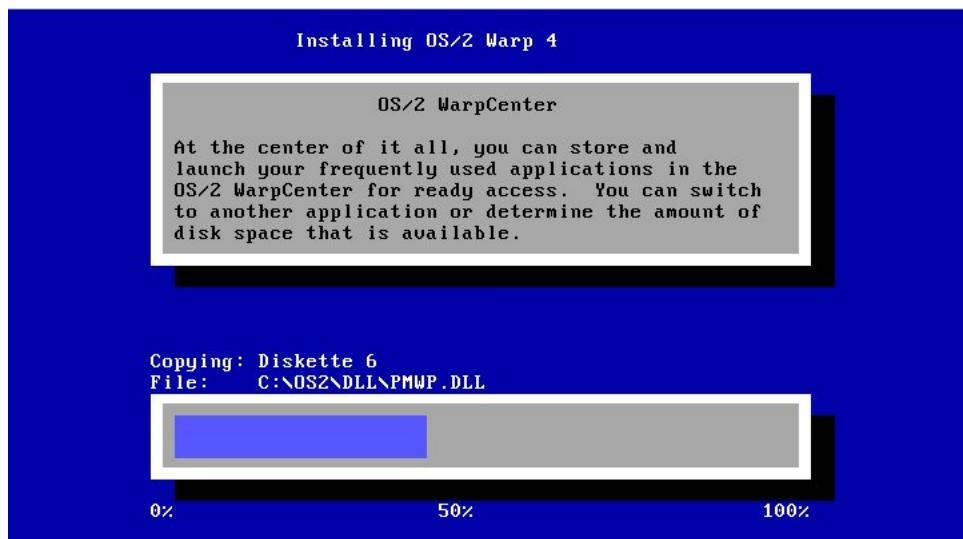


Figure 6: OS files being transferred from client disk to local bootable partition

## Graphical installer - configuration

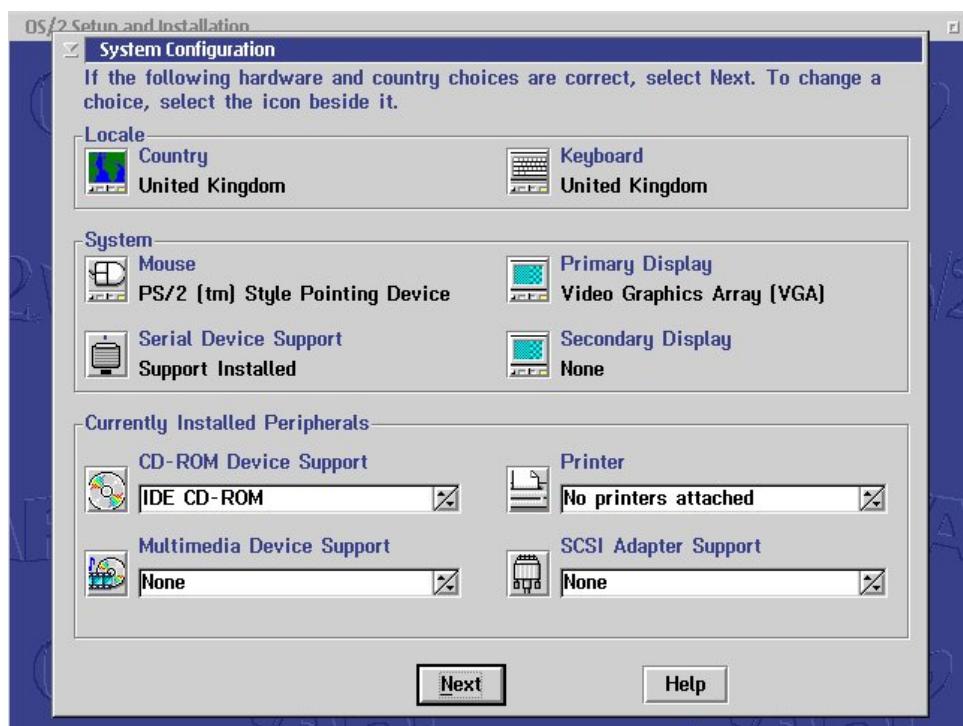


Figure 7: After file copying, the installer allows for the configuration of system devices

## Choosing features

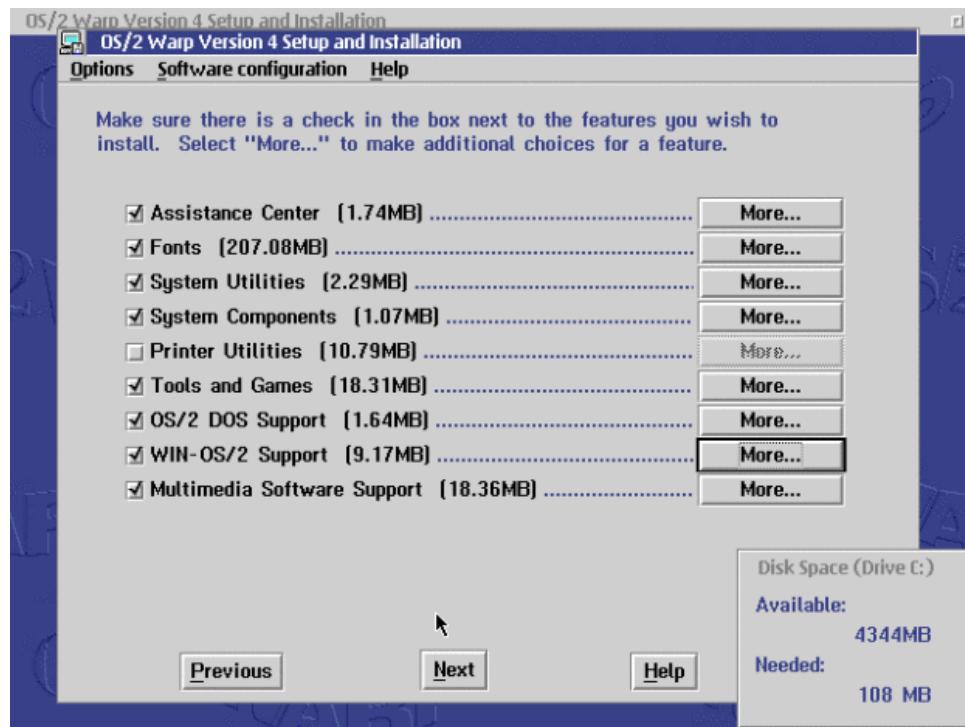


Figure 8: Choosing features to install

## Additional utilities

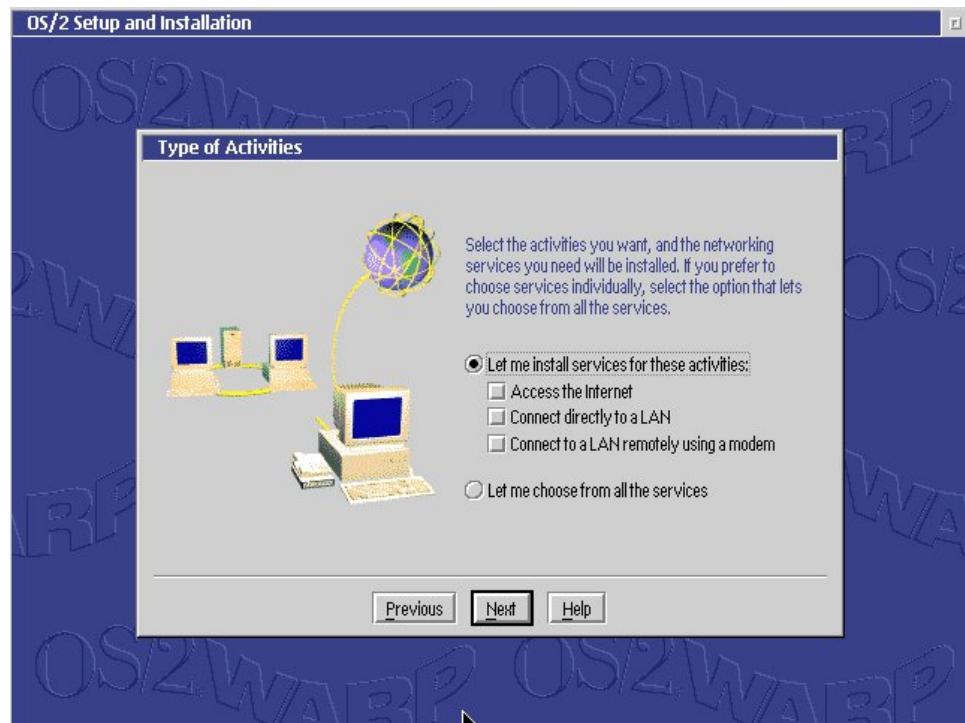


Figure 9: Choosing to install additional features to connect to the Internet and play media (Flash player)

## Final desktop



Figure 10: Final desktop after installation, showing system status and desktop, with applications installed.

## FEATURES OF OS/2 :

- Performance:

**Pre-emptive Multitasking:** The operating system determines the sharing of overall resources to achieve optimal system performance.

**Multithreading:** Multiple units of work operate to improve overall performance.

**Async Read-Ahead:** This file system enhancement studies disk read pattern, anticipates a disk read and makes it available in memory to improve system throughput.

**System Page Tuning:** Frequently used functions are grouped together to load with least no. of I/O op.

**Crash Protection:** Applications are isolated so corrupt programs wouldn't corrupt well-behaved programs.

**Disk Cache:** Frequently referenced disk location are stored in memory ready to use.

- Connectivity:

Network Adapters and Protocol Services: NDIS  
Version 2.0-L device driver support variety  
of LAN adapters

Dynamic IP Client: Supports Dynamic Host  
Configuration Protocol (DHCP) and Dynamic  
Domain Name Service (DNS)

Variable Subnet Routing: A system with  
multiple LAN adapter cards can function  
as an IP router

IP Alias Support: Allows a system with a  
single adapter card to have several IP  
addresses.

Multicast: Allows packets to be transmitted  
to multiple users

FTP and TFTP client and server: File  
transfer to and from a remote host.  
FTP is now 32-bit with usability  
enhancements and TFTP security built-in

## • Application Compatibility:

**Security Enabling Services:** Enables Installable Security Subsystem to provide robust operating systems security services.

**OS/2, DOS, Windows Support:** OS/2 Warp supports OS/2, DOS, Windows applications

**OpenDoc:** Runtime support for cross-platform compound documents.

**Open32:** To ease the porting of 32-bit windows application, support for a subset of Win 32 APIs and messages is available.

**OpenGL:** It is an highly precise 3D rendering API

**Input Queue Processing Improvements:** OS/2 Warp includes an OS/2 solution to detect misbehaved application that cause system hangs

**Dual Boot:** with dual boot, a user can switch back and forth between OS

- Hardware Support:

Plug-and-Play (P-n-P) support: OS/L warp enhanced P-n-P support automatically detects and installs enabled drivers for legal ISA devices and PnP devices without user intervention.

Self-Monitoring Analysis and Reporting Tech.

The OS/L warp includes a user interface that warns users of impending hard drive failure.

Network Printing: OS/L warp has powerful new printing capabilities.

- System Management:

System Dump Formatter: This function allows the kernel to take a system dump and have the dump information formatted by generic report generator

First Failure Support Technology (TM): FFST captures data relevant to an error at the time error occurs.

## Graphical User Interface

Graphical user interface is a form of user interface that allows users to interact with electronic devices through graphical icons and audio indicator.

## Graphical User Interface in OS/2

\* The graphic system has a layer named presentation manager that manages windows, fonts and icons.

# Workplace shell (WPS) introduced in OS/2 2.0 WPS is an object-oriented shell allowing the user to perform traditional computing tasks such as accessing files, printers, launching legacy programs, and advanced object oriented tasks.

# WPS follows IBM's Common User Access interface standards.

# WPS represents objects such as disks, folders, files, program objects, and printers which are shared using the System Object Model, allowing applications, possibly written in different programming languages.

# One of the most notable feature of System object model (SOM) is that it supports inheritance.

- \* The multimedia capabilities of OS/2 are accessible through Media control interface commands.
- \* The last update in OS/2 has added support for MP3G files. Support for newer formats such as PNG, JPEG, Ogg and MP3.
- \* OS/2 Work 4.0 was released in 1996, its new features includes new graphical icons and widgets.
- \* The interface includes OpenGL support, OpenDoc support, and a full Java Development kit, which includes Java Virtual machine.
- \* Network interface built in provides access to the internet, as well as support for IBM LAN server.
- \* The OS/2 workplace shell graphical interface was similar to Windows and Mac. Originally known as presentation manager(PM).
- \* It is a 32-bit interface with multitasking and multithreading.

# OS/2 Command Line Interface Features

→ What is a Command line interface?

Ans: It is a tool that processes the commands to a computer program in the form of line of text.

Operating Systems usually implement a command line interface in a shell for interactive access to operating System functions OR services.

## The OS/2 command line utilities:

- The command line utilities comprises of suite of native pure 32-bit OS/2 commands that provide many useful abilities to the OS/2 user,
- they are called 'command line' utilities because they are all driven by the command line making them useful in command scripts.

## FEATURES:

- Pure 32-bit code: The utilities contain no 16-bit code whatsoever, and use no 16-bit OS/2 subsystems. They are designed to always use the native paradigms of 32-bit OS/2 wherever possible, and to operate in

or way that takes best-advantages of the way that 32-bit OS/2 works and 32-bit OS/2 features.

Example: They make use of 32-bit code OS/2's ability to scan directories efficiently, handling multiple directory entries in a single system call.

No year 2000, 2100 problems: All the utilities that deal with dates are fully capable of handling dates beyond the year 2000, beyond the year 2038 - which is 'drop dead' date for much 32-bit C & C++ code.

→ the ability in 'touch' and 'xdir' commands has revealed two year 2100 bugs in OS/2's own FAT & HPFS filesystem drivers.

#### Standard conformant timezone support:

The 'Setdate', 'Settime', 'anaclock', 'digclock', 'touch' and 'unstamp' commands understand the timezone information supplied in TZ environment variable, using the standard POSIX syntax, and can operate in anytimezone, in either hemisphere with day light savings time changes happening automatically without human intervention.

→ Different commands thus be run in different timezones.

No more arbitrary 16-bit limits: All the utilities were limited only by available virtual memory.

Example: commands were not upset by large directories. The 'dir' command in IBM's cmd, the default command interpreter supplied with IBM OS/2, refuses to sort a directory listing containing more than 2073 files.

Filter commands usable in command pipelines:

The dump, find, grep, sort, etc commands can be used as filter commands, for use in a command pipeline acting upon what they receive from their standard input and producing results on their standard output.

→ localisation support: All the utilities can display the date & time in the format appropriate to the current settings given for country in CONFIG.SYS. They also use OS/2's system message file to display errors and so will display error messages in local language.

## Some commands of OS/2:

1) Command: cd

interpret: This is also known as chdir (change directory) is a command line ~~scripts~~ shell command used to change the current working directory.

2) Command: chkdsk

interpret: This command verifies the file system integrity of volumes and attempts to fix logical file system errors.

3) Command: cls

interpret: cls itself stands for clear screen and this command is used to clear the screen (or) console window of commands and any output generated by them.

4) Command: cmd.exe.

interpret: This is the default command line interpreter for the OS/2. This when executed gives the version of the cmd as output.

5) command: comp

interpret: This command is used to perform comparisons of multiple computer files to show the difference between them. When executed asks for input of 2 files if present in same directory returns the difference between them.

6.) command: copy

interpret: This command takes in 2 arguments filename & path and copies files from one directory to another.

7.) command: dir

interpret: This command is used for computer files & directory listing.

8.) command: del

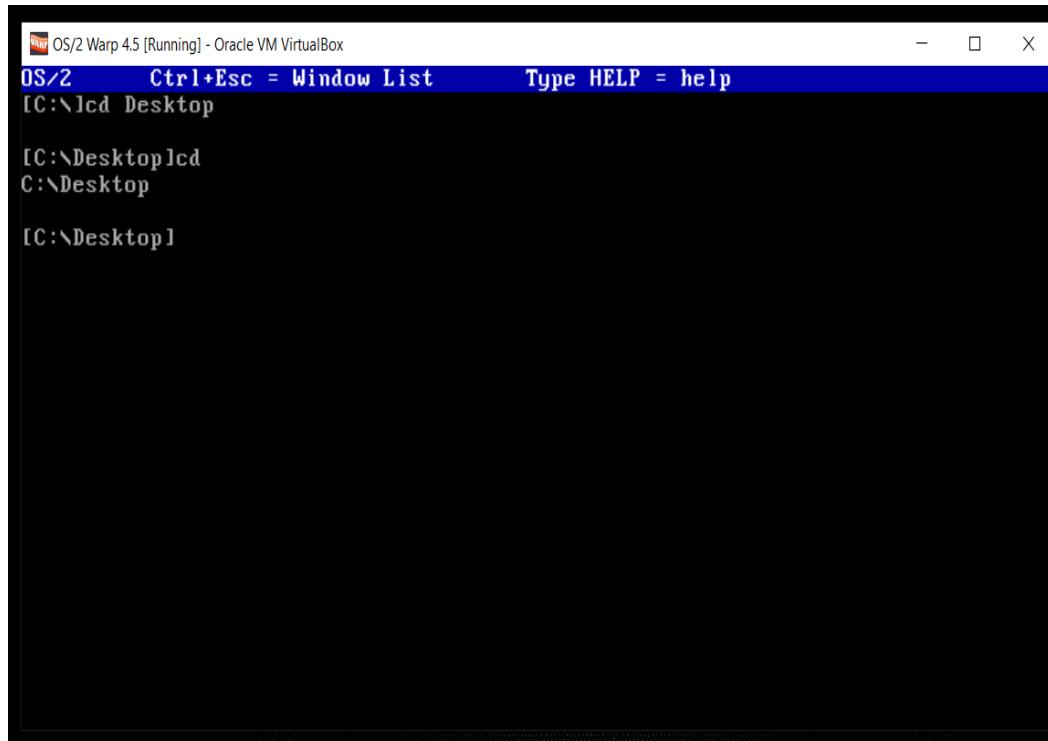
interpret: This command is used to delete one (or) more files (or) directories from file system.

9.) command: ifconfig

interpret: This has features of configuring controlling & querying TCP/IP network interface parameters.

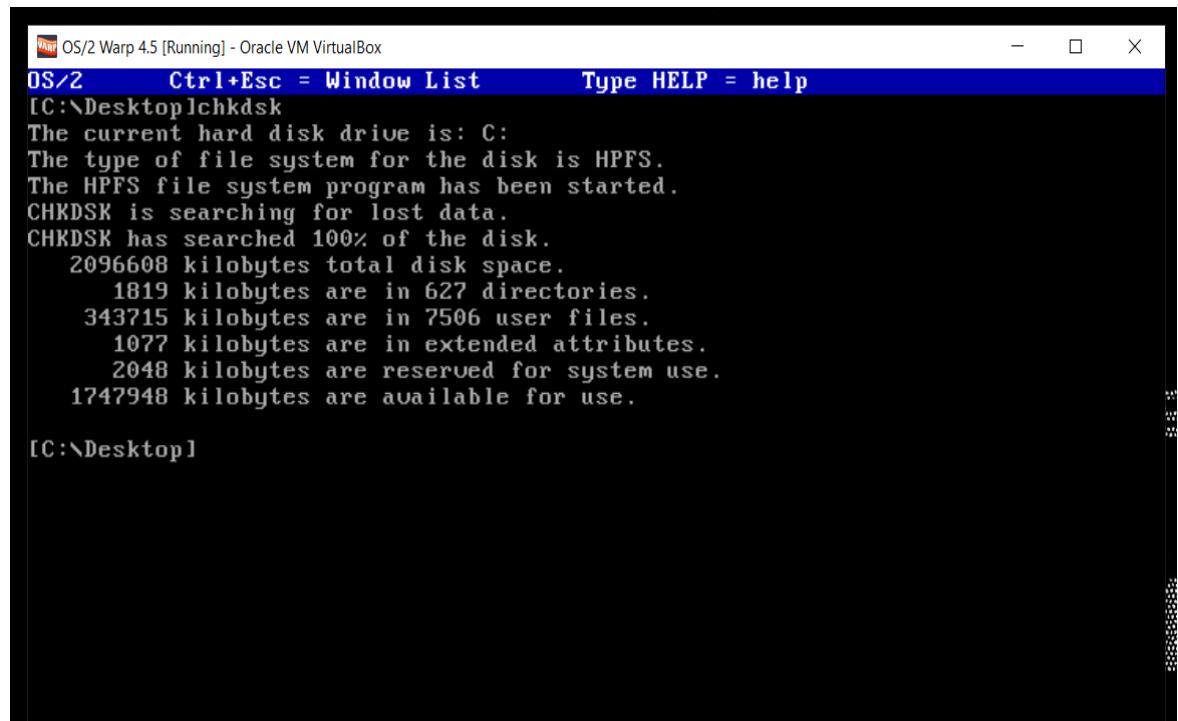
Trying out the commands:

## 1. Cd



```
OS/2 Warp 4.5 [Running] - Oracle VM VirtualBox
OS/2      Ctrl+Esc = Window List      Type HELP = help
[C:\]cd Desktop
[C:\Desktop\]cd
[C:\Desktop]
[C:\Desktop]
```

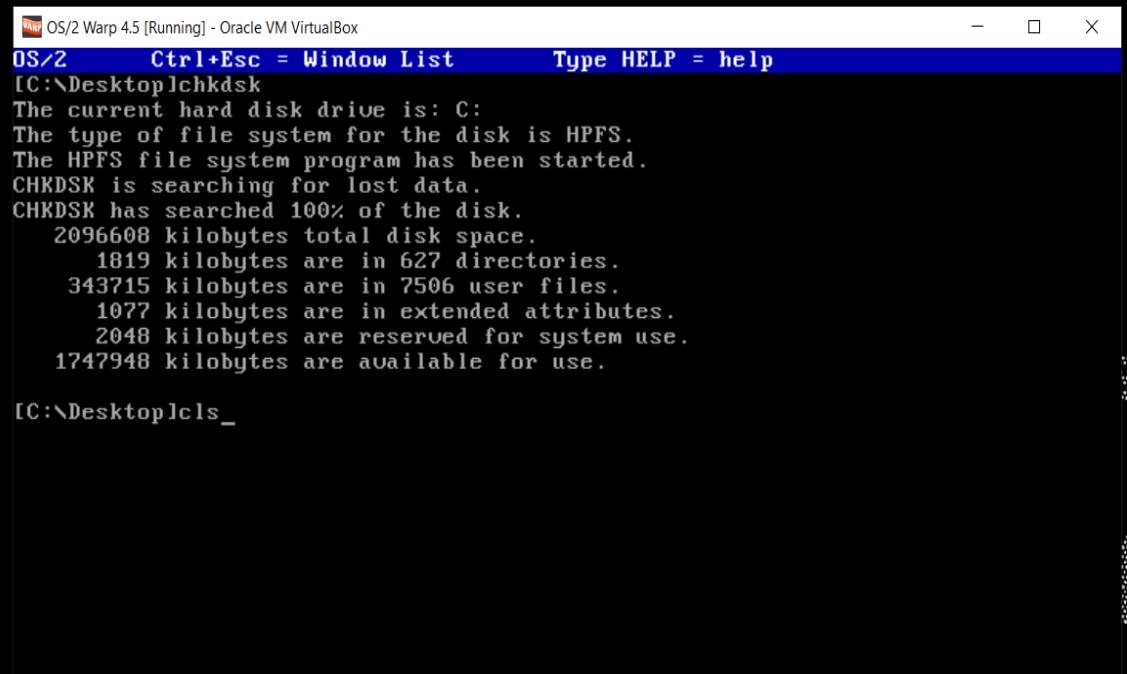
## 2. Chdsk



```
OS/2 Warp 4.5 [Running] - Oracle VM VirtualBox
OS/2      Ctrl+Esc = Window List      Type HELP = help
[C:\Desktop\]chkdsk
The current hard disk drive is: C:
The type of file system for the disk is HPFS.
The HPFS file system program has been started.
CHKDSK is searching for lost data.
CHKDSK has searched 100% of the disk.
 2096608 kilobytes total disk space.
    1819 kilobytes are in 627 directories.
  343715 kilobytes are in 7506 user files.
   1077 kilobytes are in extended attributes.
   2048 kilobytes are reserved for system use.
1747948 kilobytes are available for use.

[C:\Desktop]
```

## 3. cls



OS/2 Warp 4.5 [Running] - Oracle VM VirtualBox

OS/Z      Ctrl+Esc = Window List      Type HELP = help

[C:\Desktop\lchkdsk

The current hard disk drive is: C:

The type of file system for the disk is HPFS.

The HPFS file system program has been started.

CHKDSK is searching for lost data.

CHKDSK has searched 100% of the disk.

2096608 kilobytes total disk space.

  1819 kilobytes are in 627 directories.

  343715 kilobytes are in 7506 user files.

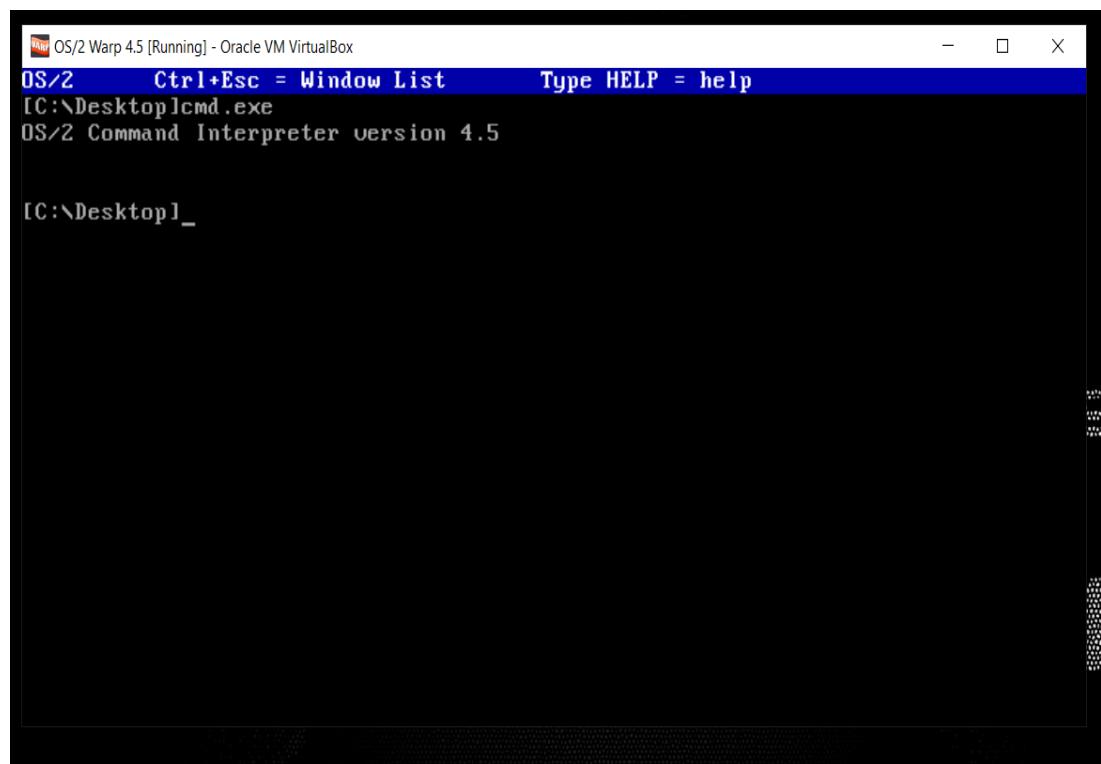
  1077 kilobytes are in extended attributes.

  2048 kilobytes are reserved for system use.

1747948 kilobytes are available for use.

[C:\Desktop\lcls\_

#### 4. cmd.exe



OS/2 Warp 4.5 [Running] - Oracle VM VirtualBox

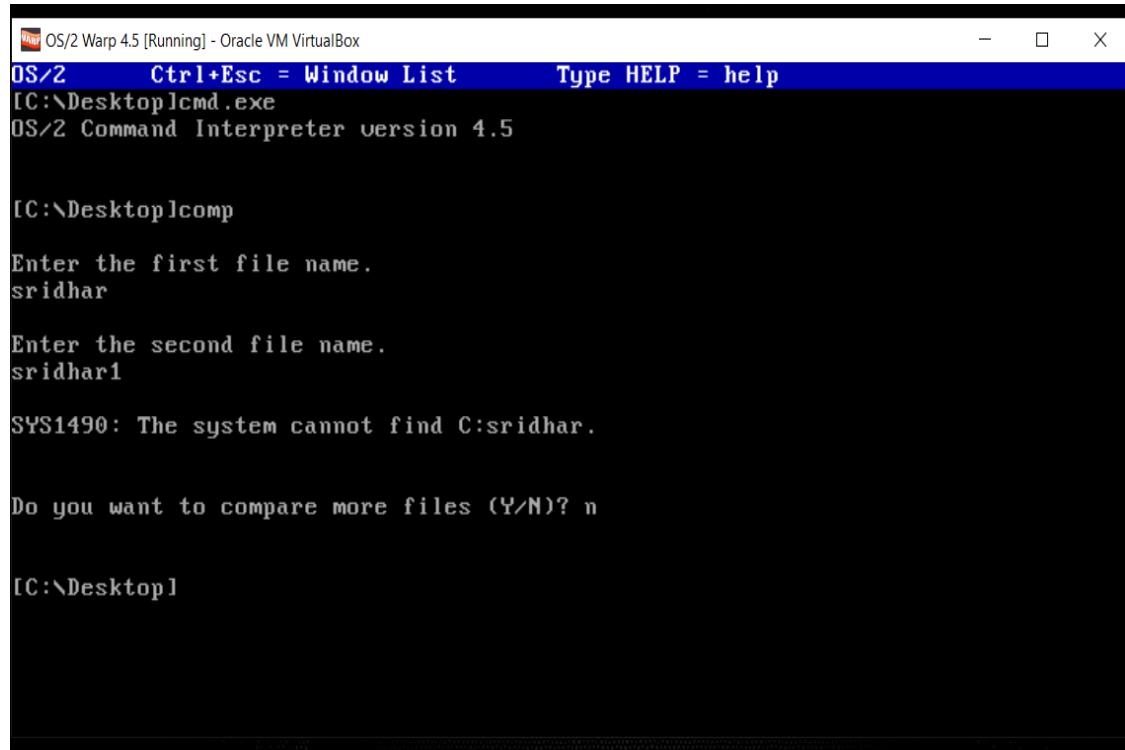
OS/Z      Ctrl+Esc = Window List      Type HELP = help

[C:\Desktop\cmd.exe

OS/2 Command Interpreter version 4.5

[C:\Desktop\]

## 5. comp



```
[WARP] OS/2 Warp 4.5 [Running] - Oracle VM VirtualBox
OS/2      Ctrl+Esc = Window List      Type HELP = help
[C:\Desktop\]cmd.exe
OS/2 Command Interpreter version 4.5

[C:\Desktop\]comp

Enter the first file name.
sridhar

Enter the second file name.
sridhar1

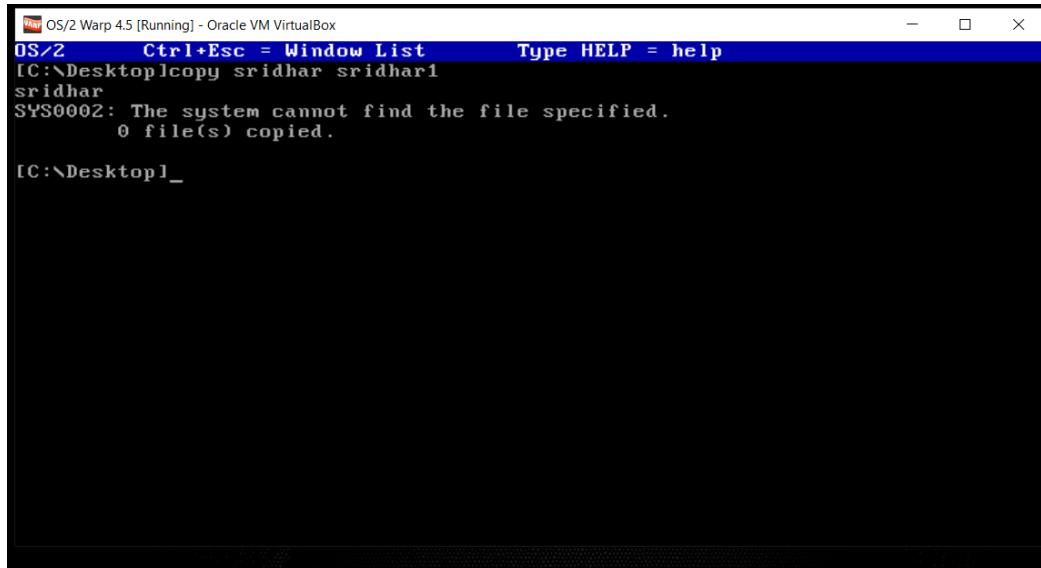
SYS1490: The system cannot find C:sridhar.

Do you want to compare more files (Y/N)? n

[C:\Desktop]
```

Note: The output is so because there is no file called Sridhar or sridhar1 on the Desktop.

## 6. copy



```
[WARP] OS/2 Warp 4.5 [Running] - Oracle VM VirtualBox
OS/2      Ctrl+Esc = Window List      Type HELP = help
[C:\Desktop\]copy sridhar sridhar1
sridhar
SYS0002: The system cannot find the file specified.
  0 file(s) copied.

[C:\Desktop]
```

Note: The output is so because there is no file called Sridhar or sridhar1 on the Desktop.

## 7. dir

The volume label in drive C is OS2.  
The Volume Serial Number is ACDB:E015.  
Directory of C:\Desktop

File	Date	Time	Type	Size
.	30/01/21	5:18p	<DIR>	0
..	30/01/21	5:18p	<DIR>	0
Assistance Center	30/01/21	5:18p	<DIR>	8434
Connections	30/01/21	5:18p	<DIR>	4408
IBM OS!2 Developer's Toolkit!Version 4.5	30/01/21	5:25p	<DIR>	3882
Macromedia Flash Player for OS!2^by www.innotek.de	30/01/21	5:27p	<DIR>	386
OS!2 System	30/01/21	5:18p	<DIR>	8775
Programs	30/01/21	5:18p	<DIR>	4828
TCP!IP Shadows	30/01/21	5:23p	<DIR>	8432
9 file(s)				0 bytes used
				1782609 K bytes free

[C:\Desktop]

## 8. del

OS/2 Warp 4.5 [Running] - Oracle VM VirtualBox

OS/2 Ctrl+Esc = Window List Type HELP = help

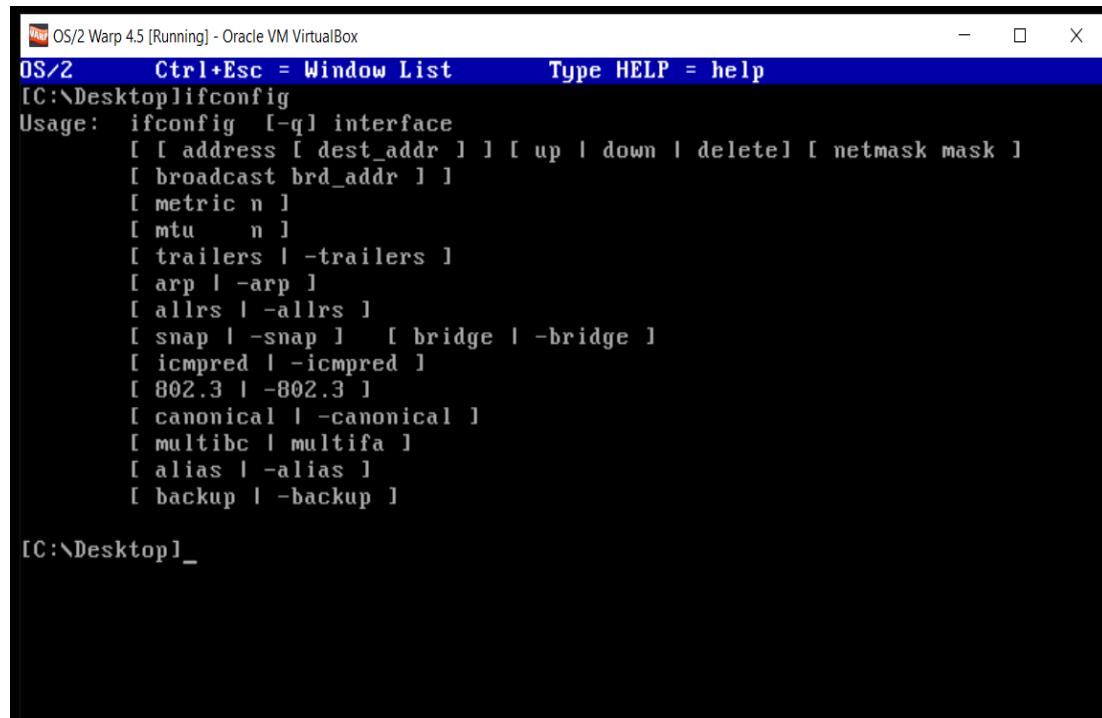
[C:\Desktop] del sridhar

SYS0002: The system cannot find the file specified.

[C:\Desktop]

Note: The output is so because there is no file called Sridhar on the Desktop.

## 9. ifconfig



The screenshot shows a terminal window titled "OS/2 Warp 4.5 [Running] - Oracle VM VirtualBox". The title bar includes standard window controls (minimize, maximize, close) and text: "OS/2 Ctrl+Esc = Window List" and "Type HELP = help". The main area displays the OS/2 command-line interface. A command prompt "[C:\Desktop\ifconfig]" is followed by the usage information for the "ifconfig" command:

```
Usage: ifconfig [-q] interface
    [ [ address [ dest_addr ] ] [ up | down | delete ] [ netmask mask ]
    [ broadcast brd_addr ] ]
    [ metric n ]
    [ mtu n ]
    [ trailers | -trailers ]
    [ arp | -arp ]
    [ allrs | -allrs ]
    [ snap | -snap ] [ bridge | -bridge ]
    [ icmpred | -icmpred ]
    [ 802.3 | -802.3 ]
    [ canonical | -canonical ]
    [ multibc | multifa ]
    [ alias | -alias ]
    [ backup | -backup ]
```

Below the usage information, the command prompt "[C:\Desktop]\\_" is visible.

## The File and Directory Management

### Objects in OS/2 & Files

In OS/2, everything represented by a desktop icon is called an "Object" and all of them fall into one of three general categories.

- A real file is something that physically takes up space on disk. It can be an executable program file, a word processor document, a bitmap, etc..
- An abstract object doesn't take up disk space, except insofar as it uses an entry in the system file. Some abstract objects don't have a visible representation, and therefore don't concern the user; but many of them occur as desktop icons with Properties notebooks.

The abstract object that is most likely on a desktop is a Program Object. That, in effect, is a pointer to an executable program file.

- A shadow is a pointer to a real file or a pointer to an abstract object.

Real File → An object on a computer that stores

data, information, settings, or commands used with a computer program.

**Directory** → A directory is a location for storing files on the computer. In OS/2, directories are found in a **hierarchical file system** (the drives, folders, and files are displayed in groups, which allows the user to see only the files they're interested in seeing.)

## System and Management

While providing support for many different file systems, OS/2 Warp prefers IBM's proprietary **High Performance File System (HPFS)**, which implements the operating system's native file management functions. In OS/2's infancy, it used the **FAT (File Allocation Table)** file system, but due to its limitations and shortcomings of the inefficient system, led to the development of HPFS. The HPFS file system which was first introduced with OS/2 1.2 to allow for greater access to the larger hard drives that were then appearing on the market.

HPFS provides all the standard file management functions such as opening/closing, creating/deleting, and reading/writing files and directories, as well as providing some file security and other functions via various file attributes.

HPFS uses the directory organization of FAT, but added automatic sorting of the directories based on filenames. Filename length was extended to up to 254 characters. It offers resistance to file fragmentation, improved media error handling and smaller cluster size. HPFS also allowed a file to be composed of "data" and special attributes to support other naming conventions and security. In addition, allocation units were changed from clusters to physical sectors, reducing lost disk space.

HPFS handles directories differently than FAT. Under HPFS, a directory holds what is known as the **Attribute File**, which includes information about the modification, creation, and access dates and times. Also, instead of pointing to the first cluster of the file, as does FAT, the directory entries under HPFS point to the Fnode. The Fnode can contain the file's data, or pointers that may point to the file's data or to other structures that will eventually point to the file's data.

OS/2 Warp's High Performance File System clearly offers some advantageous features concerning its file management options and performance capabilities.

### File Data Structures - Implementation of file System

OS/2 Warp implements its native file system through various data structures including Fnodes,

sector runs, B+ trees, and B- trees, each which plays an important role in the high performance of HPFS.

Every file or directory is fixed on a structure called Fnode. The Fnode is the first sector allocated to a file or directory. Each Fnode contains control and access history information, extended attributes, access control lists, the file length, the first 15 characters of the file or directory name, and an allocation structure, which defines the size and location of the file's storage through a collection of sections of contiguous bytes, called sector runs (Frommert).

Although directories logically have a different meaning than files, the file system treats directories similarly to files and their implementation requires similar structures. Directories are also fixed to Fnodes. A pointer to the Fnode for the root directory resides in the Super Block.

Directories can grow to any size. They are built from 2 kB directory blocks with each block containing one to many directory entries. These directory entries contain time and date stamps, an Fnode pointer, a usage count, the length of directory name, the name itself, and a B-Tree pointer. When a directory becomes too large to be

stored in one directory block, additional blocks are allocated in a B-tree arrangement. The entries in a directory block are sorted in alphabetical order, with a dummy entry marking the end of the block. This automatic sorting makes searching for a specific name very fast and efficient, even when searching a large B-tree.

OS/2 Warp's file data structures including Fnodes, sector runs, B+trees, and B-trees allow for quick, efficient implementations of operations on files and directories, providing a vast improvement in file system performance.

### System Calls:

This interface invokes intended system call in OS kernel and returns status of the system call and any return values. File management is a type of system call.

### Command Shell:

The Command shell of an operating system is the part that accepts input from the user, and acts on it. Some command shells are text-mode shells, accepting typed commands. Some others are Graphical User Interface (GUI) shells, using a mouse (or other pointing device) as the primary source of command input. As supplied,

OS/2 comes with one text-mode shell and one GUI shell. One also has the option of replacing these with third-party shells.

The text-mode shell is CMD.EXE. This is the program that runs when you open an OS/2 window or full-screen session.

Using Command shell, implementation of file management related commands can be carried out.

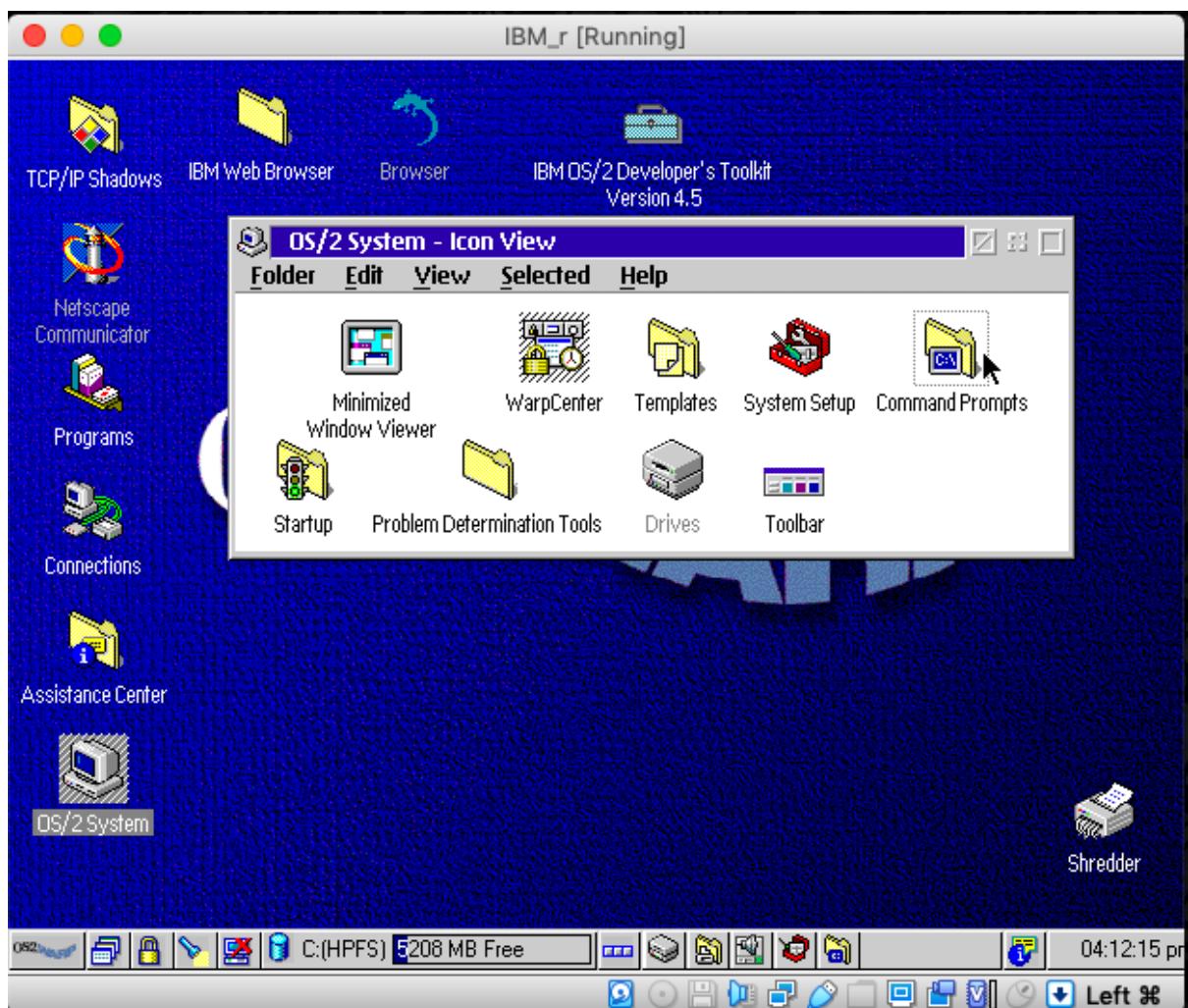
# OScasestudy- commands

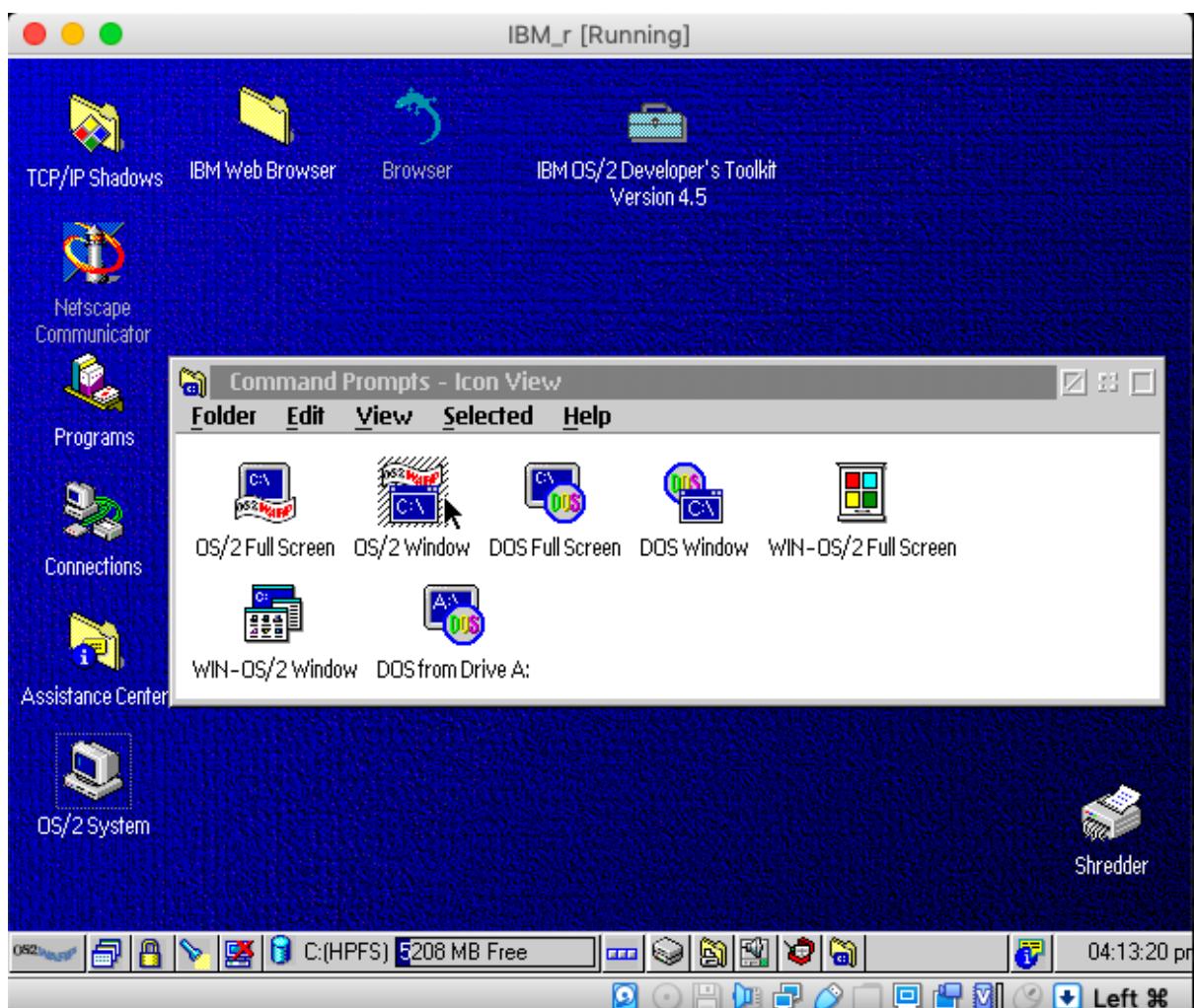
Class	CSE213
Type	Assignment

## NAVIGATING TO THE COMMAND SHELL

\*follow the cursor pointer







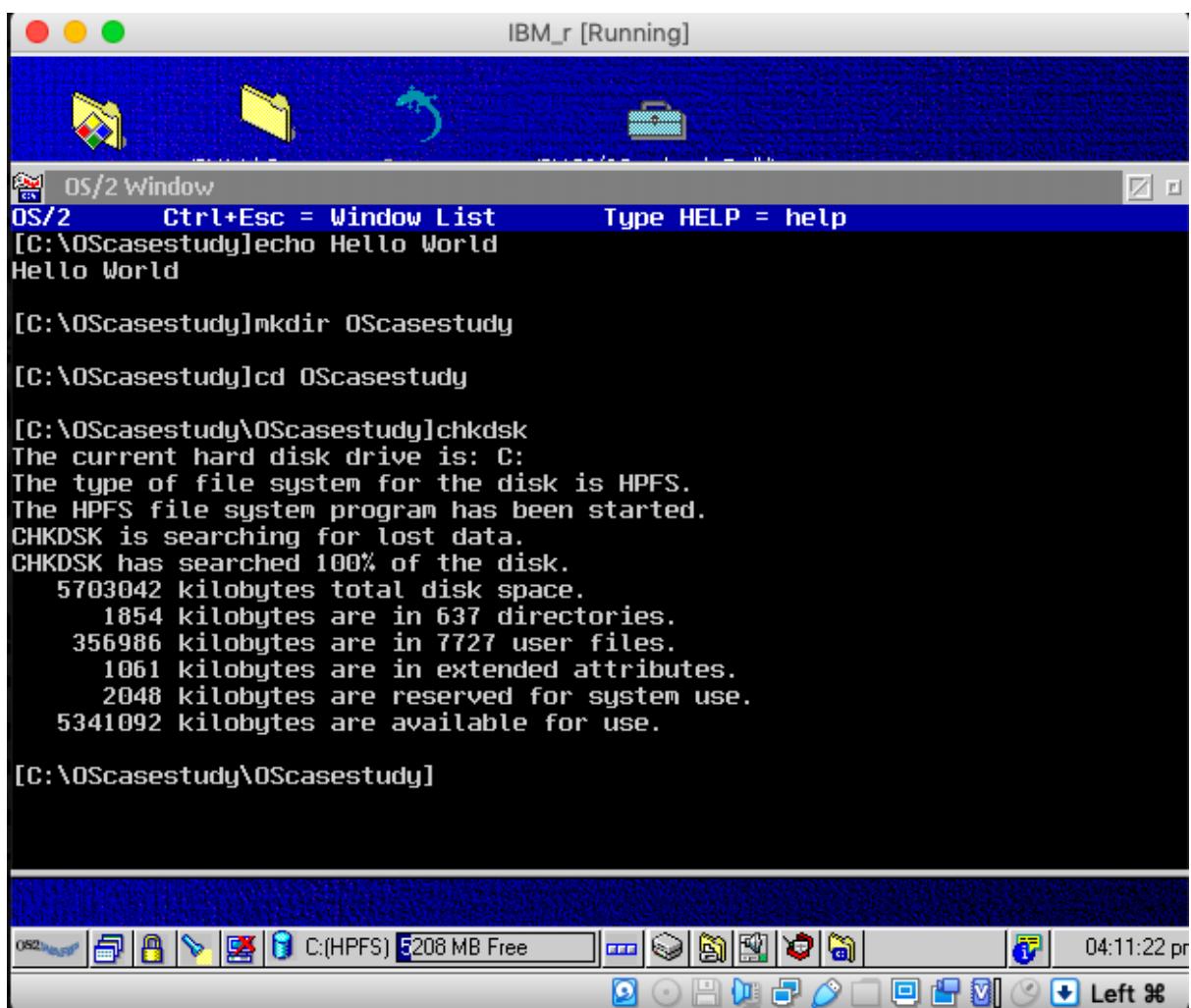
### Desktop → OS/2 System → Command Prompt → OS/2 Window

```
[C:\]CMD.EXE
OS/2 Command Interpreter version 4.5
[C:\]
```

This command starts the OS/2 command processor found in the C:\OS2 subdirectory.

## Implementation of basic commands

- **echo** : a command that outputs the strings it is being passed as arguments
- **mkdir** : Makes new subdirectories within the root directory. It creates a multilevel directory structure, which is helpful in keeping related program or data files together.
- **cd** : Changes the current directory
- **chkdsk** : Analyzes directories and files, determines the file system type, and produces a disk status report. CHKD SK also displays the volume label and the volume serial number of the disk.



The screenshot shows a window titled "IBM\_r [Running]" containing a terminal session of the OS/2 operating system. The terminal window has a blue title bar with the title and a toolbar below it. The main area displays a command-line history:

```
OS/2 Window
OS/2      Ctrl+Esc = Window List      Type HELP = help
[C:\OScasestudy]echo Hello World
Hello World

[C:\OScasestudy]mkdir OScasestudy

[C:\OScasestudy]cd OScasestudy

[C:\OScasestudy\OScasestudy]chkdsk
The current hard disk drive is: C:
The type of file system for the disk is HPFS.
The HPFS file system program has been started.
CHKDSK is searching for lost data.
CHKDSK has searched 100% of the disk.
 5703042 kilobytes total disk space.
 1854 kilobytes are in 637 directories.
 356986 kilobytes are in 7727 user files.
 1061 kilobytes are in extended attributes.
 2048 kilobytes are reserved for system use.
 5341092 kilobytes are available for use.

[C:\OScasestudy\OScasestudy]
```

The desktop background is blue with several icons: a network icon, a folder icon, a recycle bin icon, and a briefcase icon. The taskbar at the bottom shows various application icons and the system clock "04:11:22 pm".

- **cd ..** : goes back to the previous directory

```
[C:\]cd OScasestudy  
[C:\OScasestudy]cd ..  
[C:\]
```

- **ver** : Displays the OS/2 version number.

```
[C:\]ver  
The Operating System/2 Version is 4.50
```

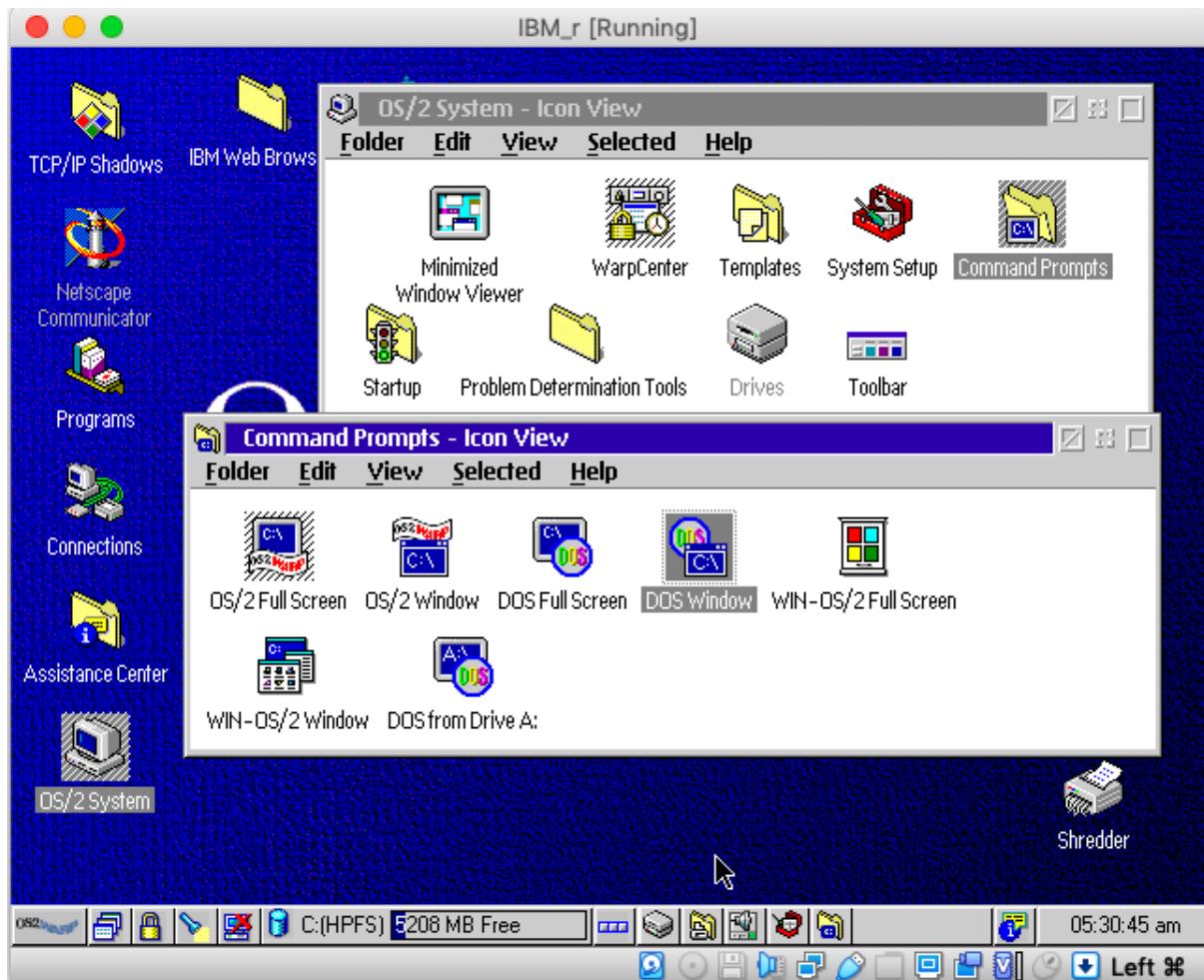
- **date** : Displays or changes the date known to the system and resets the date on your computer's clock. This date is recorded in the directory when you create or change a file.
- **time**: Displays or changes the time known to the system and resets the time on your computer's clock. This time is recorded in the directory when you create or change a file.

```
[C:\]date  
Current date is: Fri 2-12-2021  
Enter the new date: (mm-dd-yy) 2-12-2021  
  
[C:\]time  
Current time is: 16:32:25.14  
Enter the new time: _
```

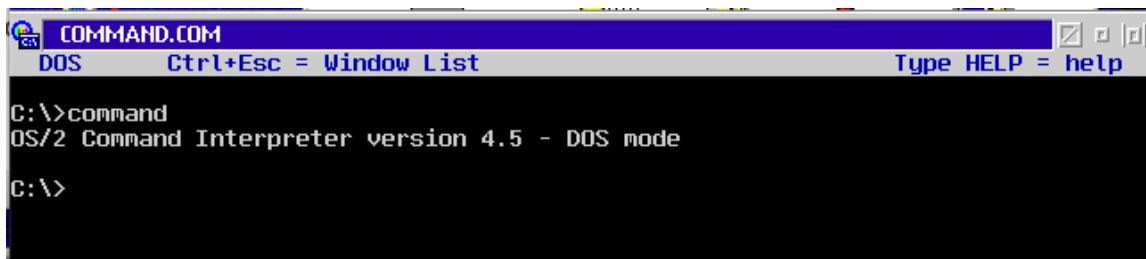
## Implementation on DOS prompt

### Navigation to the DOS prompt:

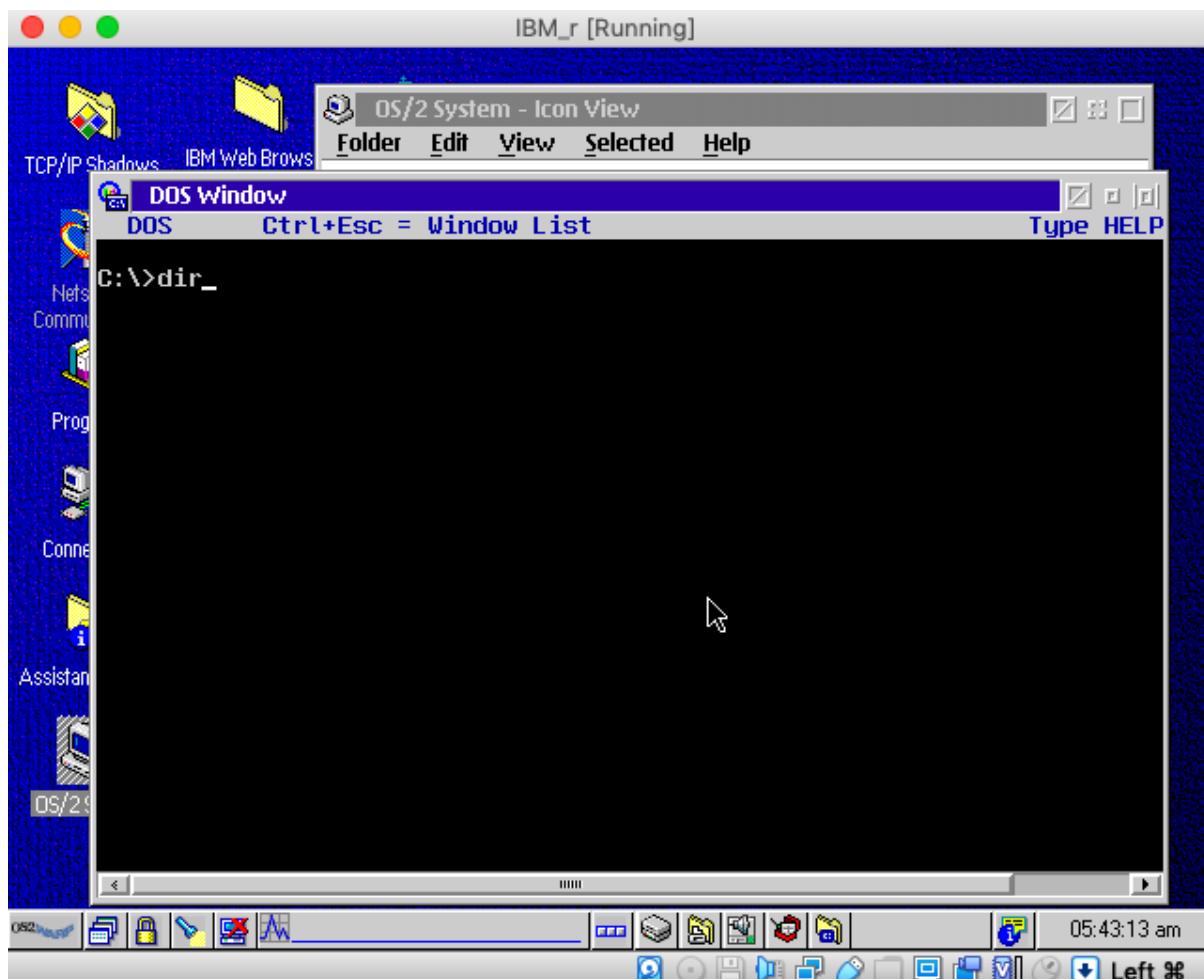
Desktop → OS/2 System → Command Prompt → DOS Window

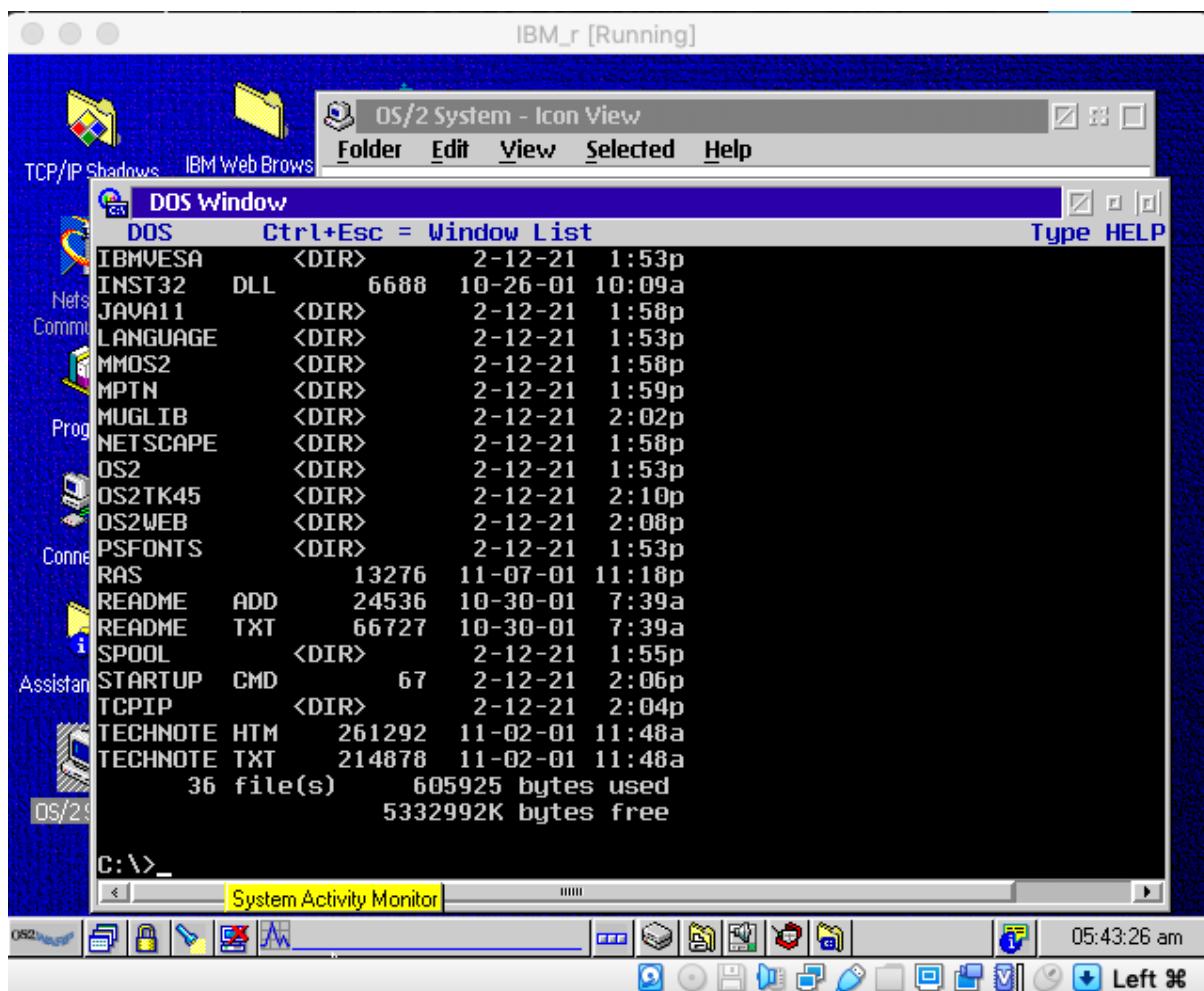


- **command** : starts the DOS command processor, COMMAND.COM, which is located in the C:\OS2\MDOS subdirectory.



- **dir** : Lists the files and subdirectories in a directory.





- **break** : Instructs DOS to check whether the Ctrl and Break keys have been pressed before carrying out a program request.

```
C:\>BREAK
BREAK is off.

C:\>
```

- **graftabl** : Loads a table of additional characters into memory for graphics mode

```
C:\>graftabl
No graphic code-page table has been loaded.
The U.S. PC version (437) of the graphic code-page table has
just been loaded.
```

- **mem** : Displays the amount of used and free memory in the DOS environment

```
C:\>mem

 655360 bytes total memory
 654336 bytes available for DOS
 588944 largest executable program size

 2473984 bytes total EMS memory
 2097152 bytes free EMS memory

 2031616 bytes total XMS memory
 2031616 bytes available XMS memory
     0 bytes available contiguous extended memory
       64KB High Memory Area available

C:\>
```