Introdução e gestão da memória

Memória Física

- ROM
  - Armazena a BIOS do sistema os programas da BIOS de arranque, num microchip
- RAM
  - Memória principal
  - Armazena temporáriamente os dados e as instruções à medida que a CPU faz o processamento
  - Perde os dados quando o computador é desligado
  - Dois tipos:
    - SRAM (static RAM)
    - DRAM (dynamic RAM)

Memoria na Board

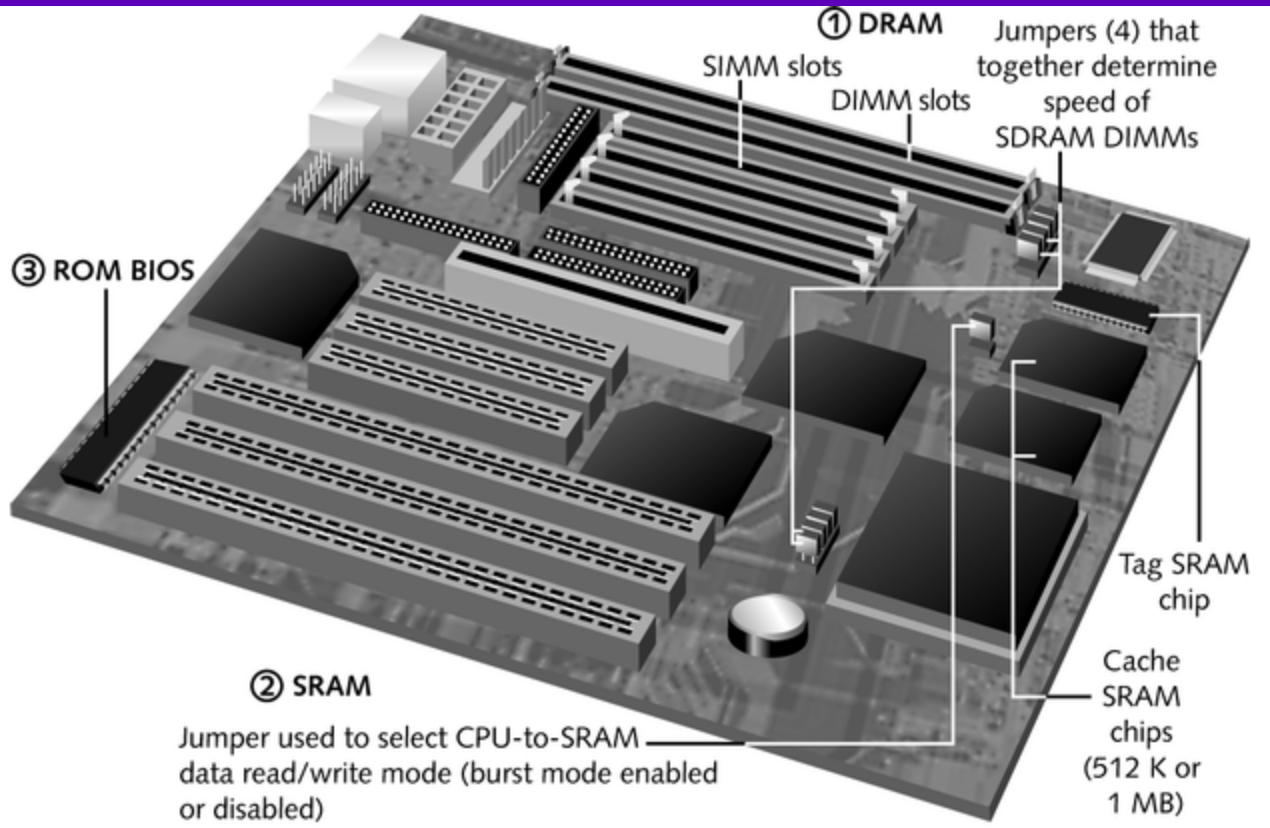


Figure 4-1 Two kinds of memory on a system board are RAM (including ① DRAM and ② SRAM) and ③ ROM; jumpers on this system board are used to control memory speed and memory mode

ROM na Board

- Consists of memory on chips that contain permanent programs
- Cons the programming computer uses to boot itself
- Contains much of the BIOS
- Is usually socketed onto the system board

Flash Memory

- Acts like secondary storage (does not lose its data when power is turned off)
- Holds data electronically
- Provides faster access than a hard drive
- Is more expensive than hard drive storage
- Uses EEPROM chips

RAM on the System Board

- Two physical ways of storage
  - Socketed or soldered directly on system board
  - Housed on very small circuit boards
- Two ways CPU uses RAM
  - As main memory
  - As a memory cache

RAM Used as Main Memory

- Physically housed on DIMM or SIMM modules
- Dynamic RAM (DRAM)

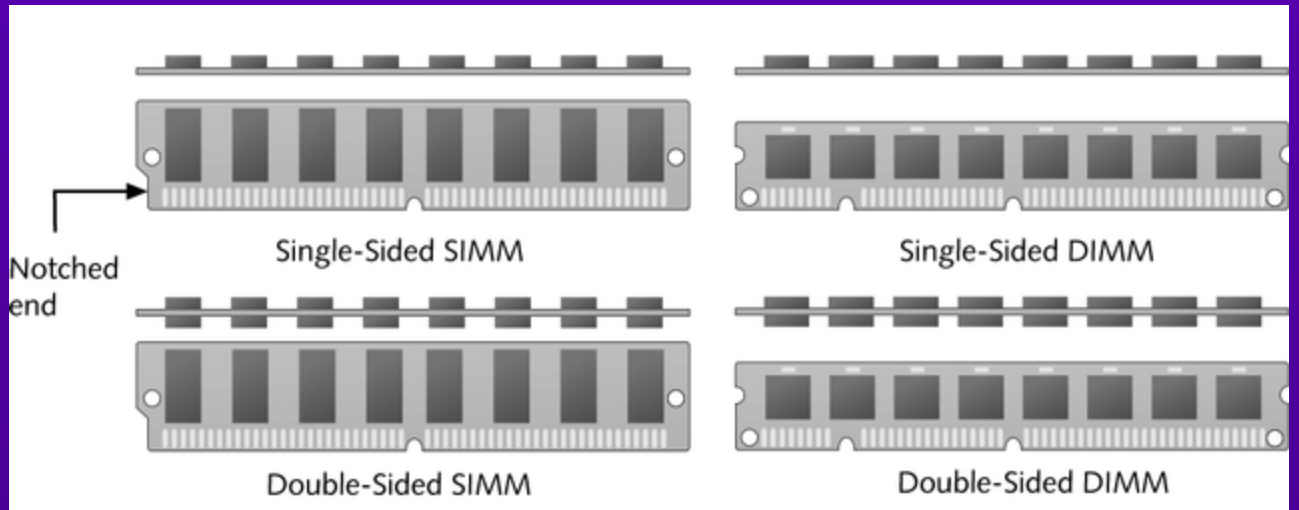
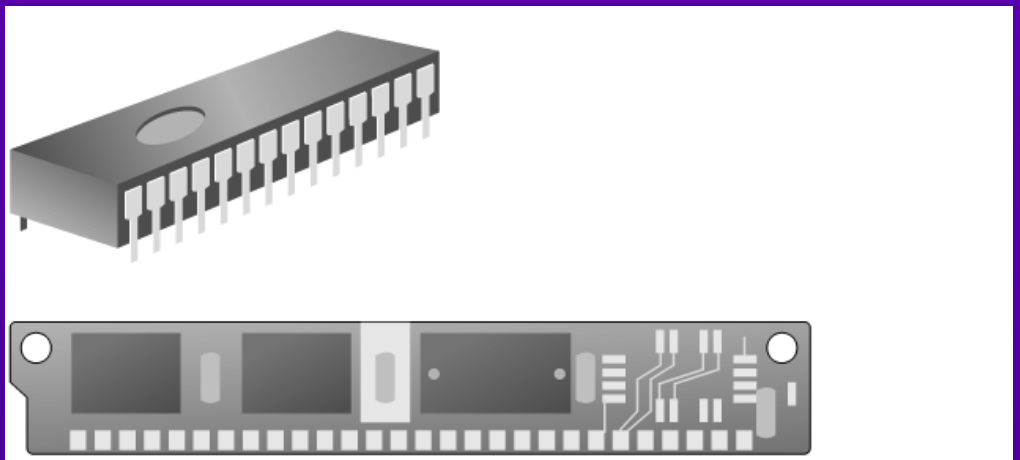


Figure 4-2 RAM on the system board is stored on SIMMs and DIMMs

RAM Used as Memory Cache

- Housed on individual chips or on a COAST
- Static RAM (SRAM)



A typical COAST module

Figure 4-3 Single SRAM chip and a COAST module

Types of Memory

Table 4-1 Types of memory

Main Memory	Cache Memory
DRAM, needs constant refreshing	SRAM, does not need refreshing
Slower than SRAM because of refreshing time	Faster, but more expensive
Physically housed on DIMMs, SIMMs	Physically housed on COAST or single chips
Technologies include: • FPM • EDO • BEDO • Synchronous DRAM (SDRAM) • Direct Rambus DRAM • Double Data Rate SDRAM	Technologies include: • Synchronous SRAM • Burst SRAM • Pipelined burst • Asynchronous SRAM
Memory addresses are assigned	No memory addresses assigned here

SRAM and Memory Caching

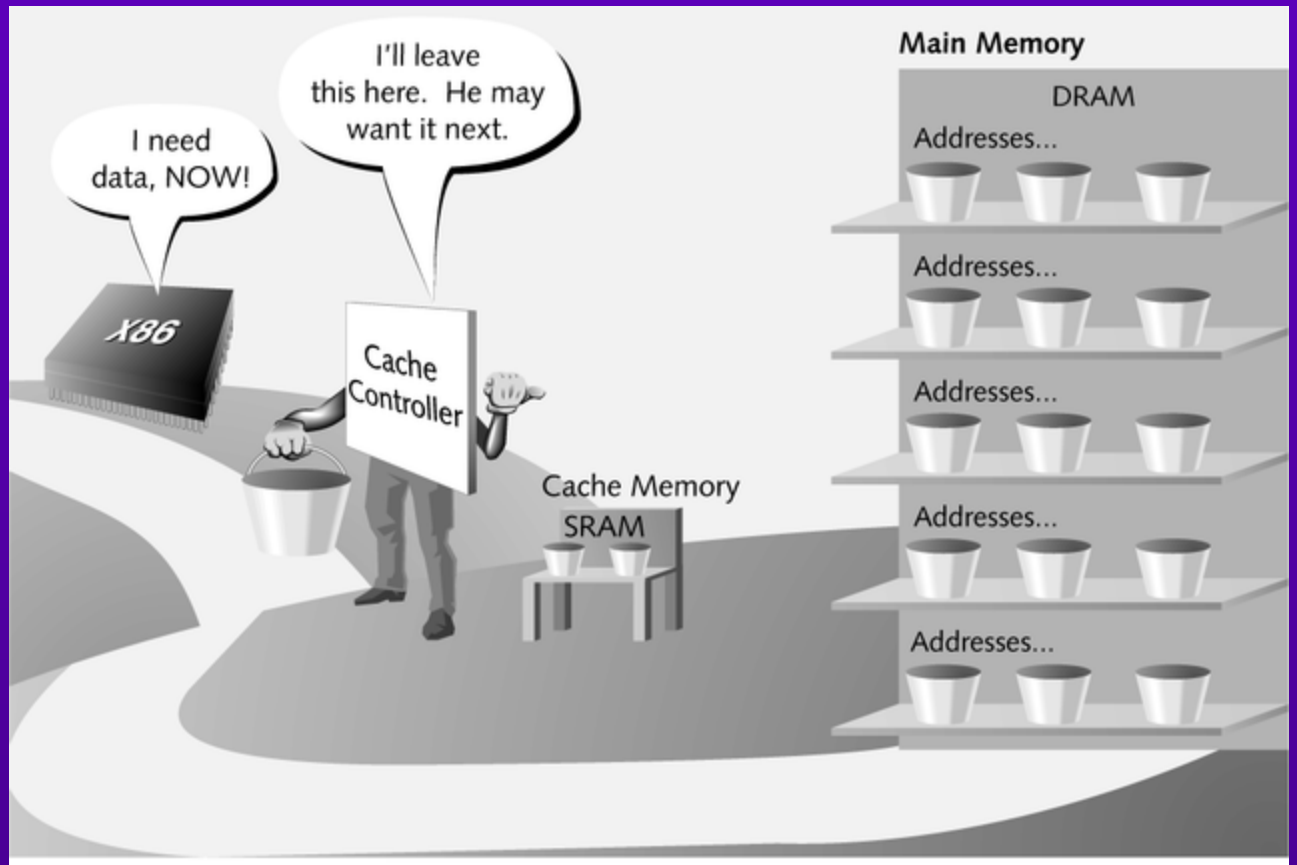


Figure 4-4 A memory cache (SRAM) temporarily holds data in expectation of what the CPU will request next

SRAM on the System Board

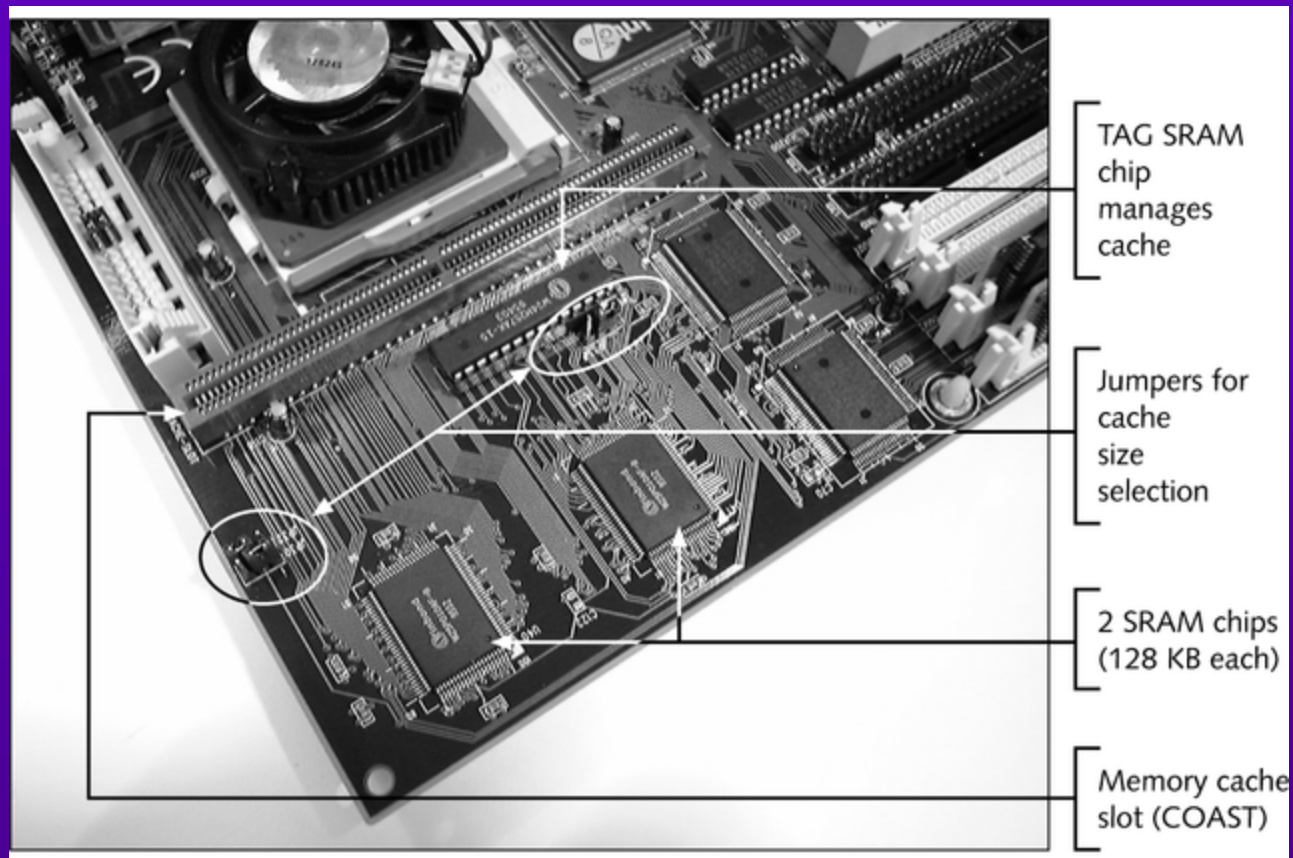


Figure 4-5 SRAM on this system board is stored in individual chips, and the board also has a COAST slot

Varieties of SRAM Memory

- Synchronous SRAM
  - Faster and more expensive than asynchronous SRAM
  - Requires a clock signal to validate control signals, enabling the cache to run in step with the CPU
- Asynchronous SRAM
  - Does not work in step with the CPU clock, and is, therefore, slower than synchronous SRAM

Main Memory: SIMMs and DIMMS

- SIMM technologies
  - Width of data path: 32 bits
  - FPM (fast page mode) memory and EDO (extended data output) memory
- DIMM
  - Width of data path: 64 bits
  - Use burst EDO or synchronous SRAM
- Future RAM technologies: Direct Rambus DRAM and Double Data Rate SDRAM
- ECC, parity, and nonparity DRAM

The DIMM Module

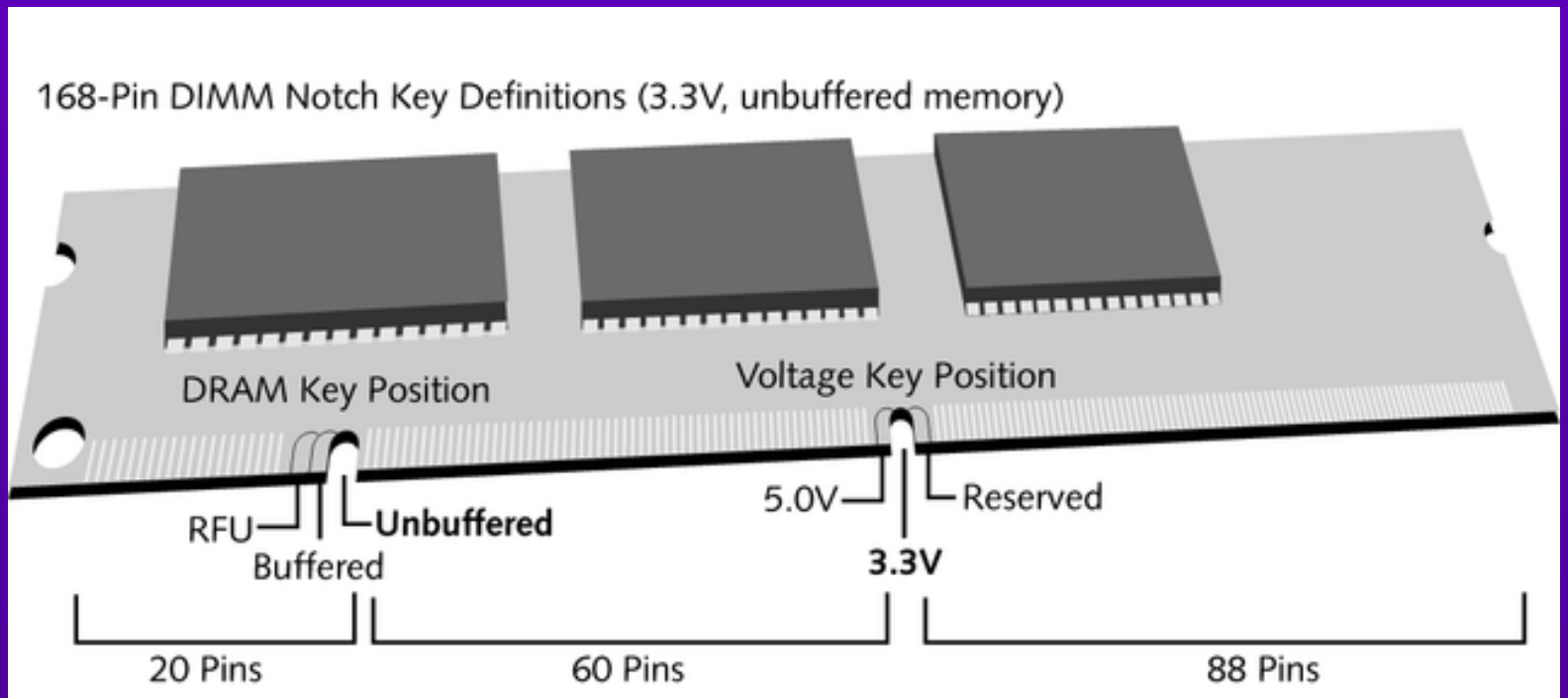


Figure 4-6 The positions of two notches on a DIMM identify the type of DIMM and also prevent the wrong type from being installed on a system board

What to Look for When Buying Memory Chips and Modules

- Memory speed
- Tin or gold leads
- Choosing the correct size of module
- Remanufactured and used modules
- Re-marked chips

Table 4-2 Summary of how operating systems have evolved in managing memory

Operating System	Real Mode	Protected Mode
DOS	Operates totally in real mode, but later offered HIMEM.SYS, a device driver that allows programs access to extended memory	NA
DOS with Windows 2.x	Operated totally in real mode, but managed the process of switching programs in and out of memory	NA
DOS with Windows 3.x	Real mode is called standard mode. Allows only one 16-bit application at a time in memory	Protected mode is called 386 enhanced mode. Multiple applications can share memory. 16-bit applications share a virtual machine.
Windows 9x	Allows real-mode drivers to be loaded during startup. 16-bit DOS applications are allowed a real-mode session.	Switches back and forth between real mode and protected mode as necessary. Supports both 16-bit and 32-bit applications in a virtual machine.
Windows NT	NA	All work is done in protected mode. Supports 32-bit applications. 16-bit applications can operate in a virtual machine only.

Physical Memory and Memory Addresses

- Memory
  - Physical microchips that can hold data and programming
  - Located on the system board or on expansion boards as single chips or modules
  - Can be either ROM or RAM
- Memory address
  - A number the CPU assigns to physical memory
  - Both ROM and RAM must be assigned memory addresses in order for the CPU to access it

Memory Addresses

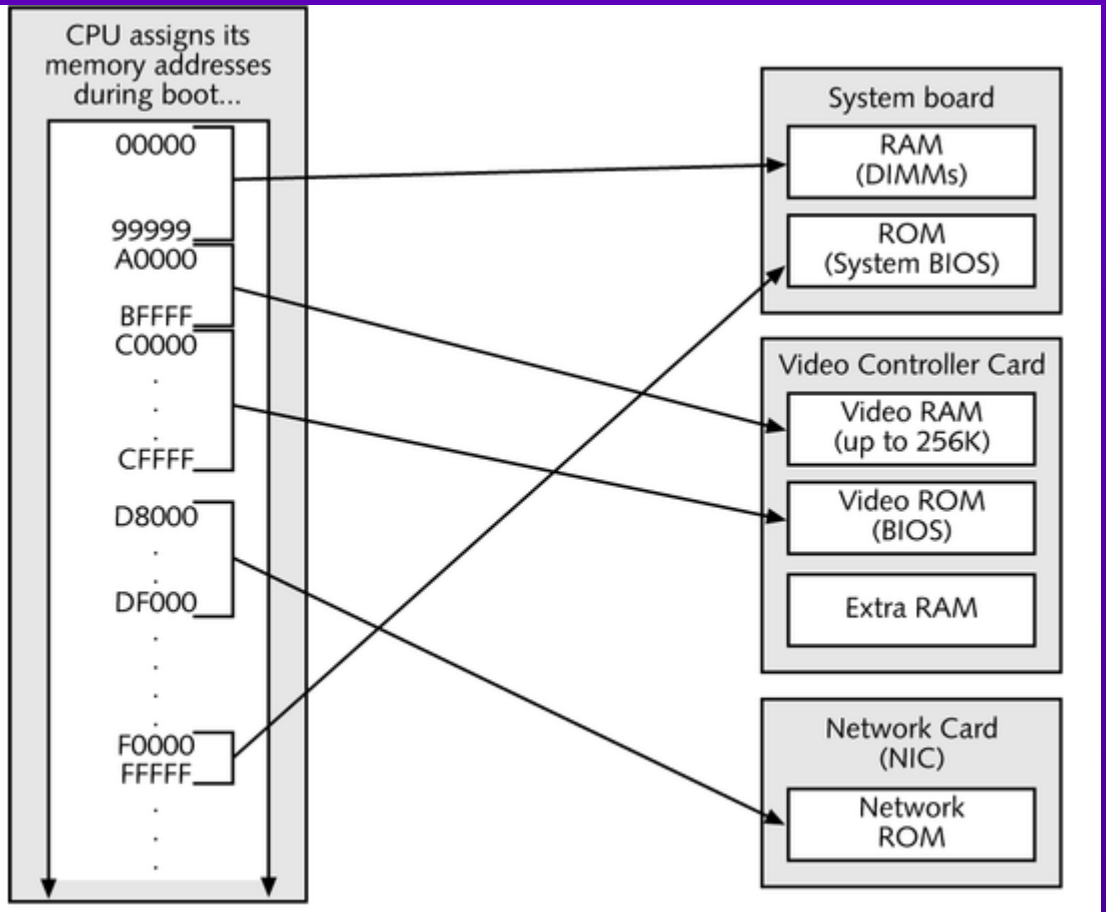


Figure 4-7 CPU assigns memory addresses during booting

Greatest Limitation of DOS

- Commitment to maintain backward compatibility with older software and hardware

Memory Management

- Process of increasing available conventional memory by loading device drivers and TSRs into upper memory
- Types of memory
  - Conventional: first 640K of memory addresses
  - Upper: memory addresses from 640K to 1024K
  - Extended: memory above 1024K
  - Expanded
    - Accessed in 16K segments by a window in upper memory
    - Falls outside of linear addressing of memory

Areas of the Memory Map

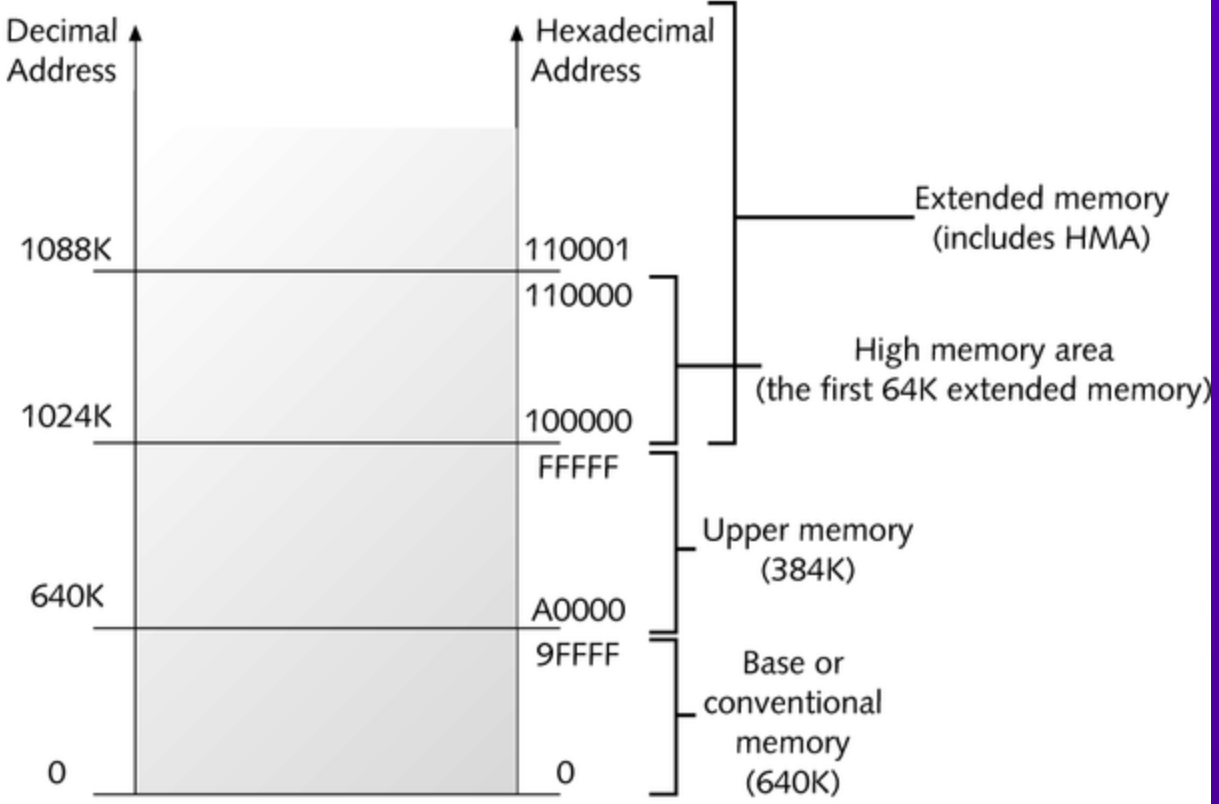


Figure 4-8 Memory address map showing the starting and ending addresses of conventional, upper, and extended memories, including the high memory area

Conventional Memory

- Designed in the 1980s
- Inadequate today due to memory requirements of:
  - Large size of most applications
  - Running more than one application at a time
  - Graphic user interfaces

Upper Memory

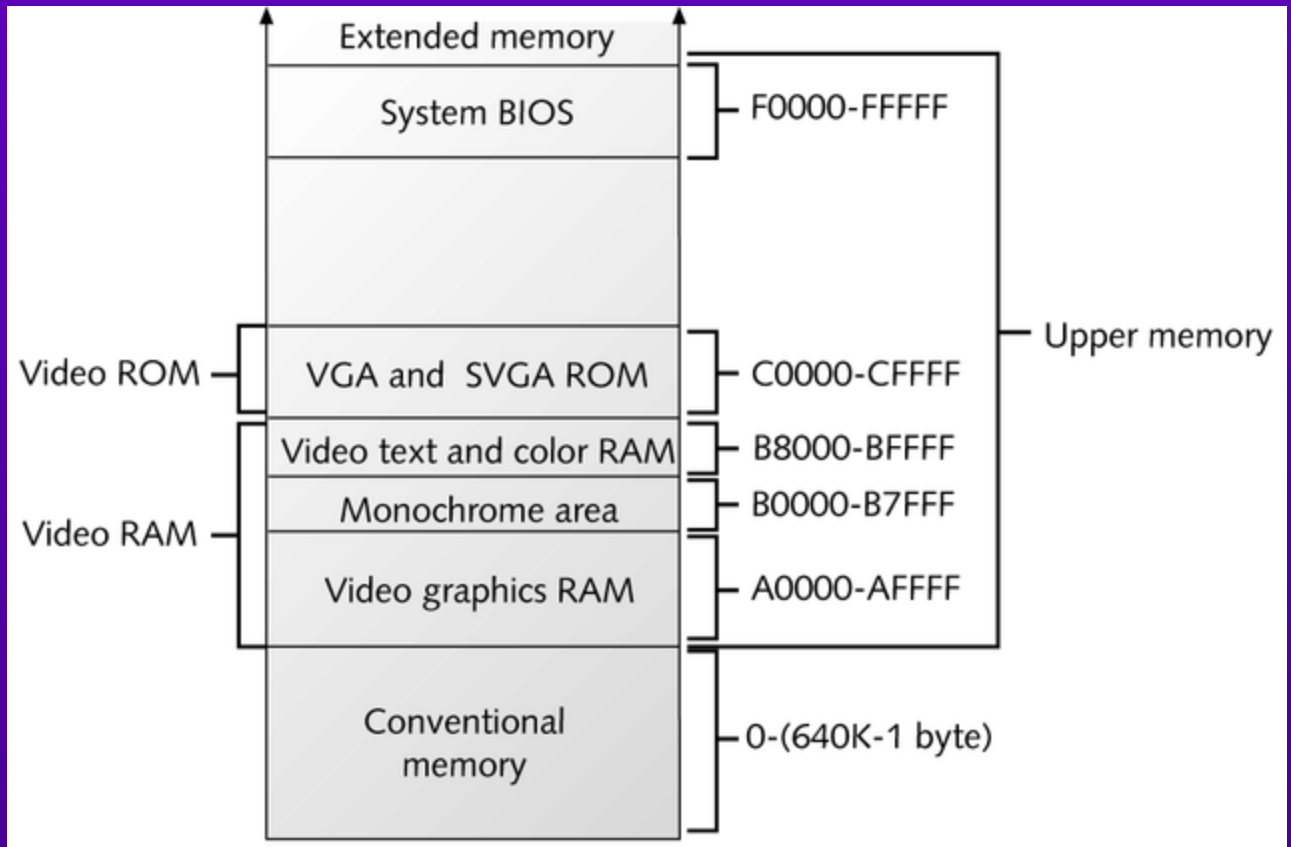


Figure 4-9 Memory map of upper memory showing starting and finishing addresses and video ROM and RAM assignments

Extended Memory and the High Memory Area

- Extended memory
  - Managed by the OS as a device controlled by a device driver called a memory manager
  - Amount is limited by amount of RAM and number of supportable memory addresses
- High memory area
  - First 64K of extended memory
  - Result of a bug in programming for 286 CPU

Expanded Memory

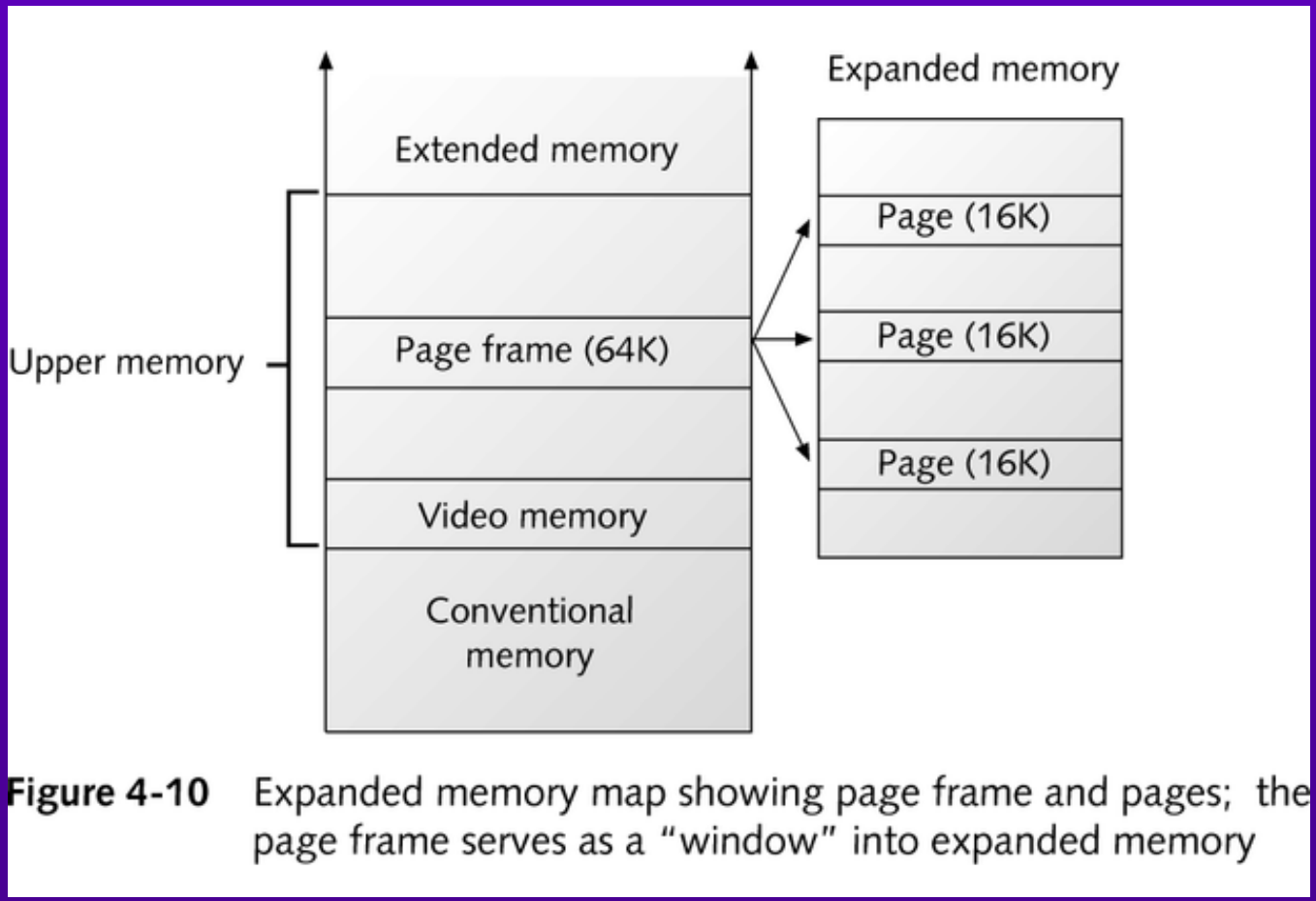


Figure 4-10 Expanded memory map showing page frame and pages; the page frame serves as a "window" into expanded memory

Virtual Memory

- Hard disk space used when a system starts to run low on RAM
- Used to increase the amount of memory available
- Works at slower speed than real memory
- Available only if OS operates in protected mode

RAM Drives

- A RAM area configured as a virtual hard drive so that frequently used programs can be accessed faster
- Opposite of virtual memory

Summary of How Memory Is Managed

- Memory management makes greatest amount of conventional memory available to an application
- During boot process
  - ROM and RAM from expansion boards acquire upper memory addresses
  - Unused addresses in upper memory are used to hold TSRs and device drivers
- Applications must be able to access extended and expanded memory

Managing Memory with DOS or Windows 3.x

- HIMEM.SYS
  - Device driver for all memory above 640K
  - Often executed by the line DEVICE = C:\DOS\HIMEM.SYS in a CONFIG.SYS file
- EMM386.EXE
  - Manages memory addresses in upper memory
  - Emulates expanded memory

Using HIMEM.SYS

Figure 4-11 CONFIG.SYS set to use memory above 640K

Using EMM386.EXE

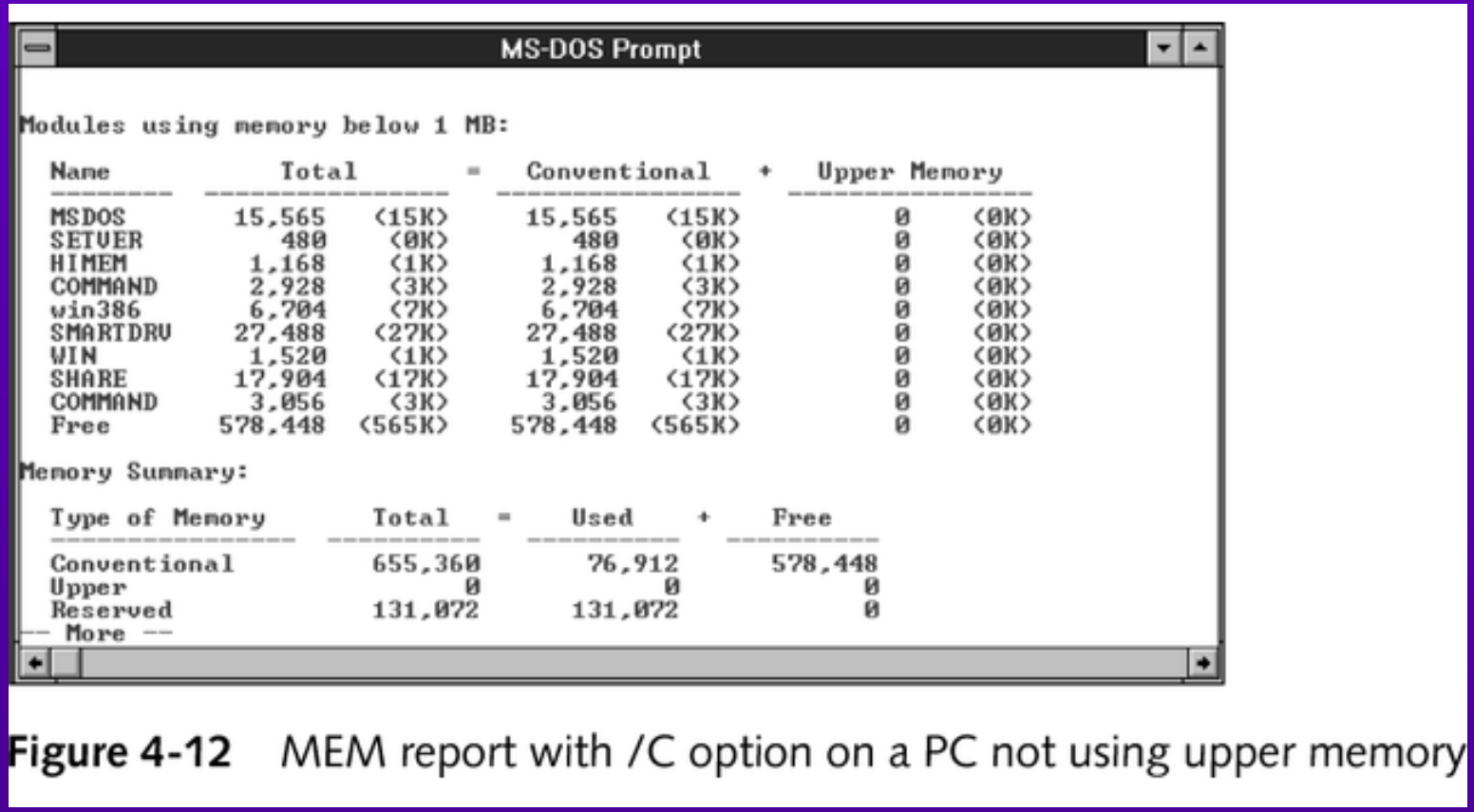


Figure 4-12 MEM report with /C option on a PC not using upper memory

Creating and Using Upper Memory Blocks

- Upper memory block (UMB)
  - A group of consecutive memory addresses in RAM from 640K to 1 MB that can be used by device drivers and TSRs
- Loading high
  - Process of loading a driver or TSR into upper memory

Creating and Using Upper Memory Blocks

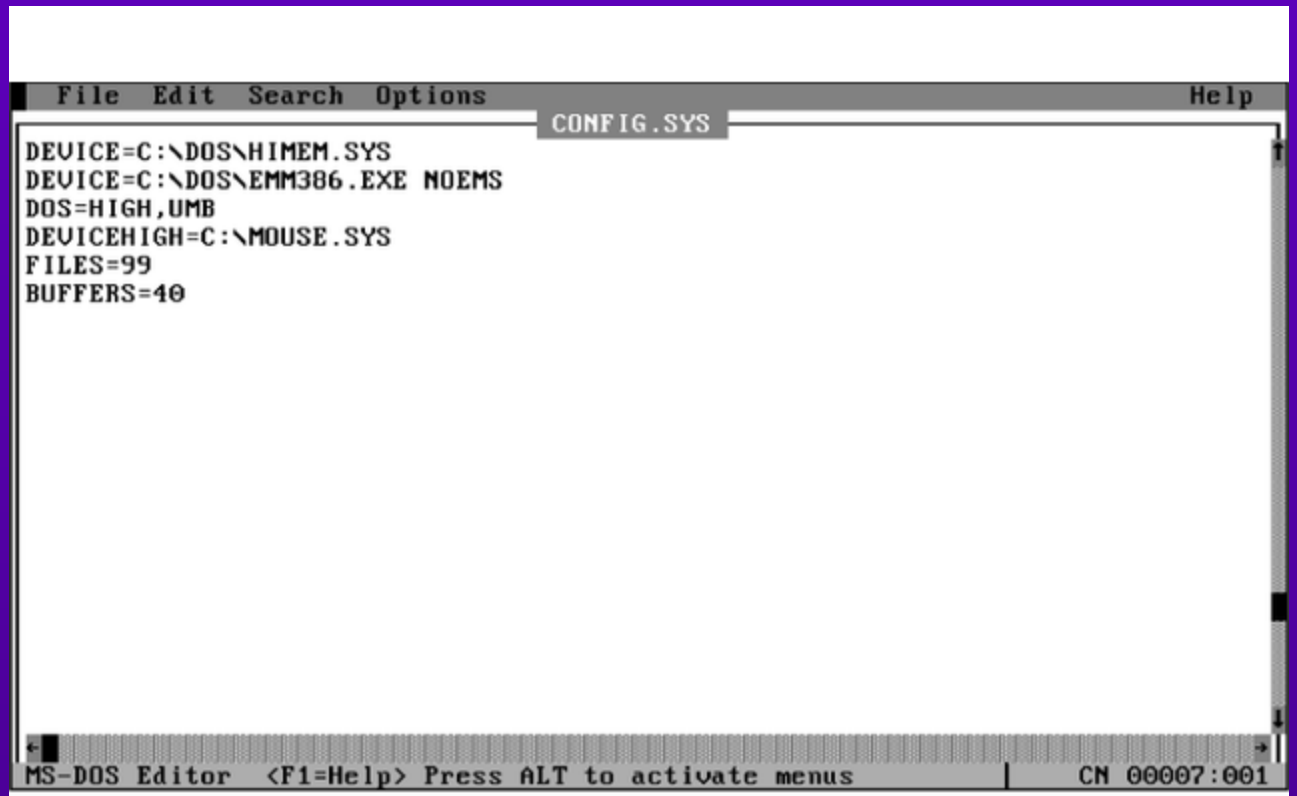


Figure 4-13 CONFIG.SYS set to use upper memory

Loading Device Drivers High

- Use the DEVICEHIGH= command in CONFIG.SYS
- Device driver needs space immediately above it to hold its data and extra room to initialize itself

Loading TSRs High

- Load TSRs that are not device drivers into upper memory from AUTOEXEC.BAT or from DOS prompt

Loading TSRs High

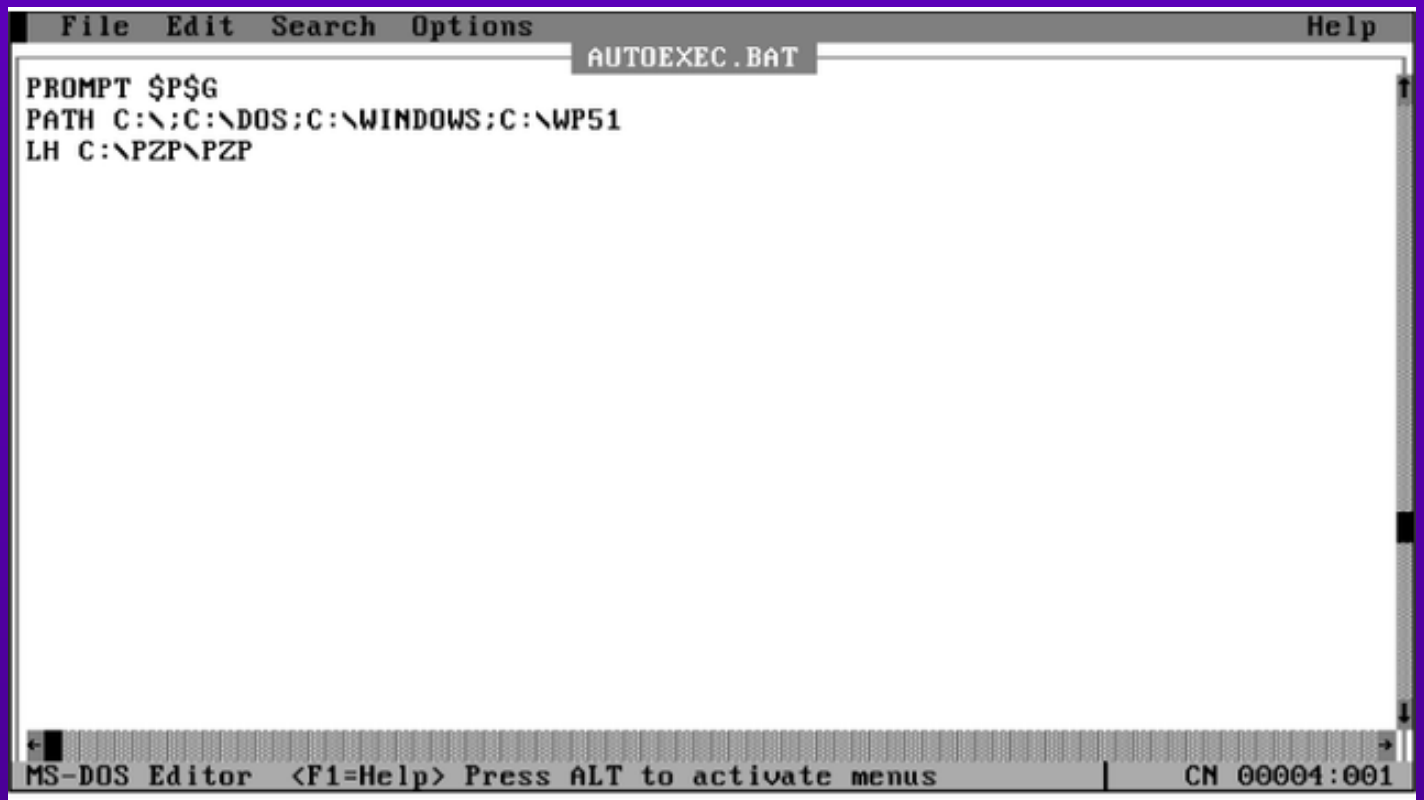


Figure 4-14 AUTOEXEC.BAT loading a TSR high

Simulating Expanded Memory

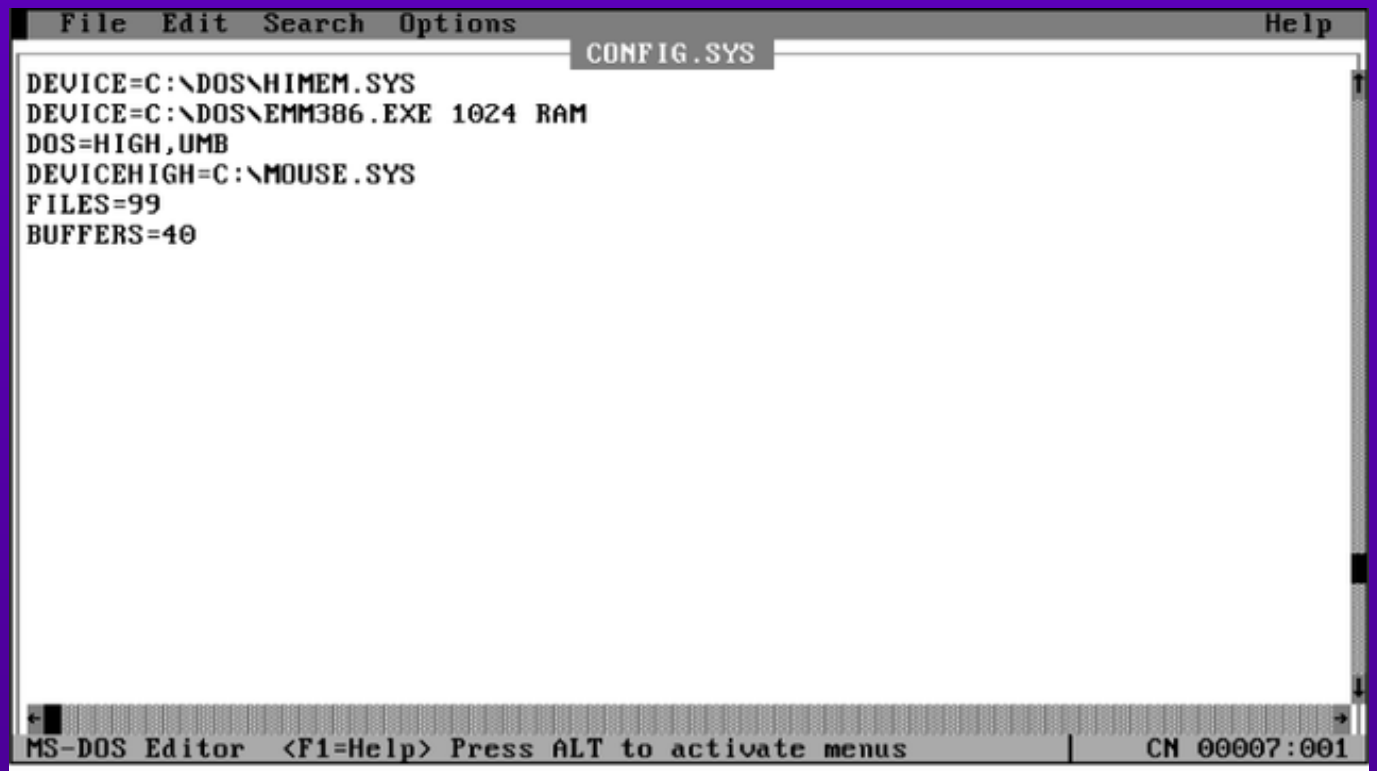


Figure 4-15 CONFIG.SYS set to simulate expanded memory

Memory Reports Using the MEM Command

- MEM command
  - A DOS utility used to display how programs and drivers are using conventional, upper, and extended memory
  - Example: MEM/C/P

Memory Reports Using the MEM Command

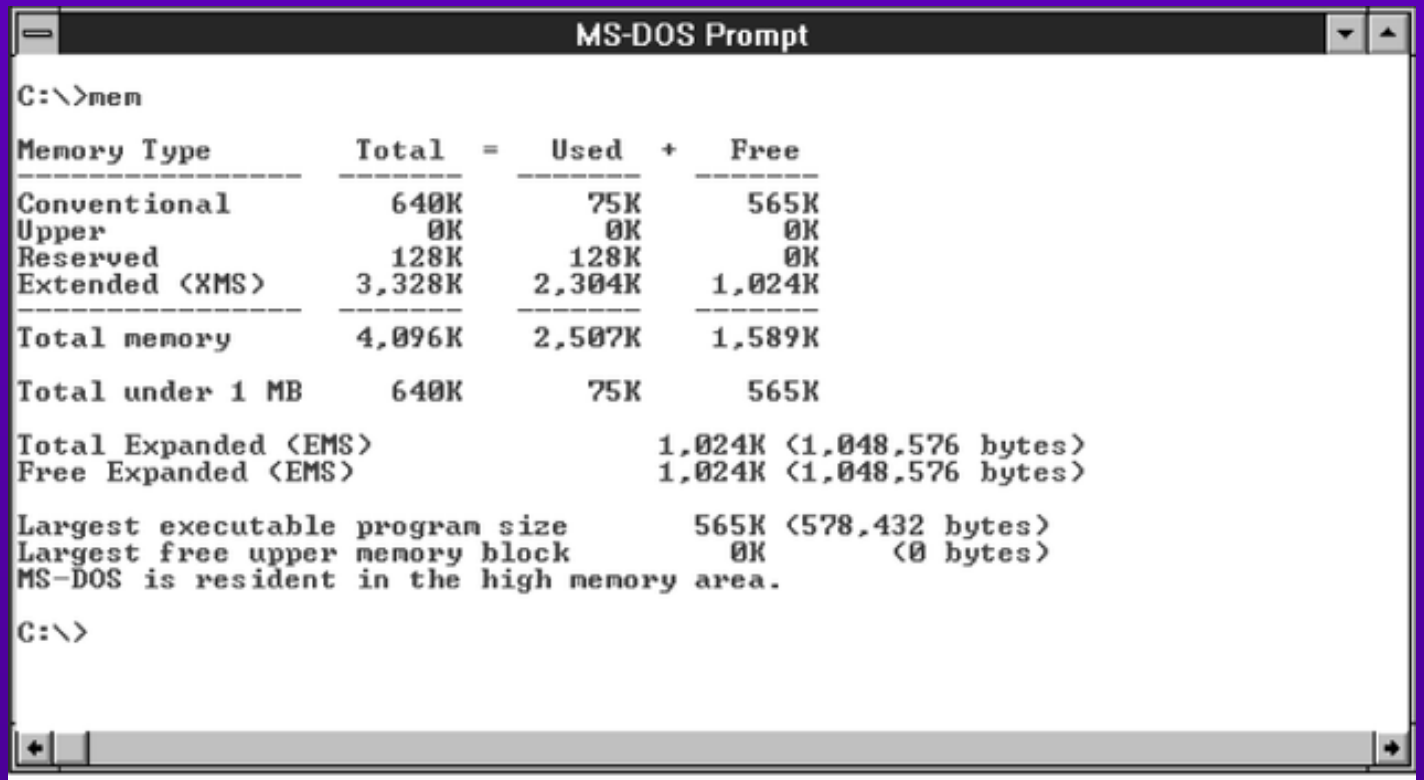


Figure 4-16 MEM report without UMBs available

Memory Reports Using the MEM Command

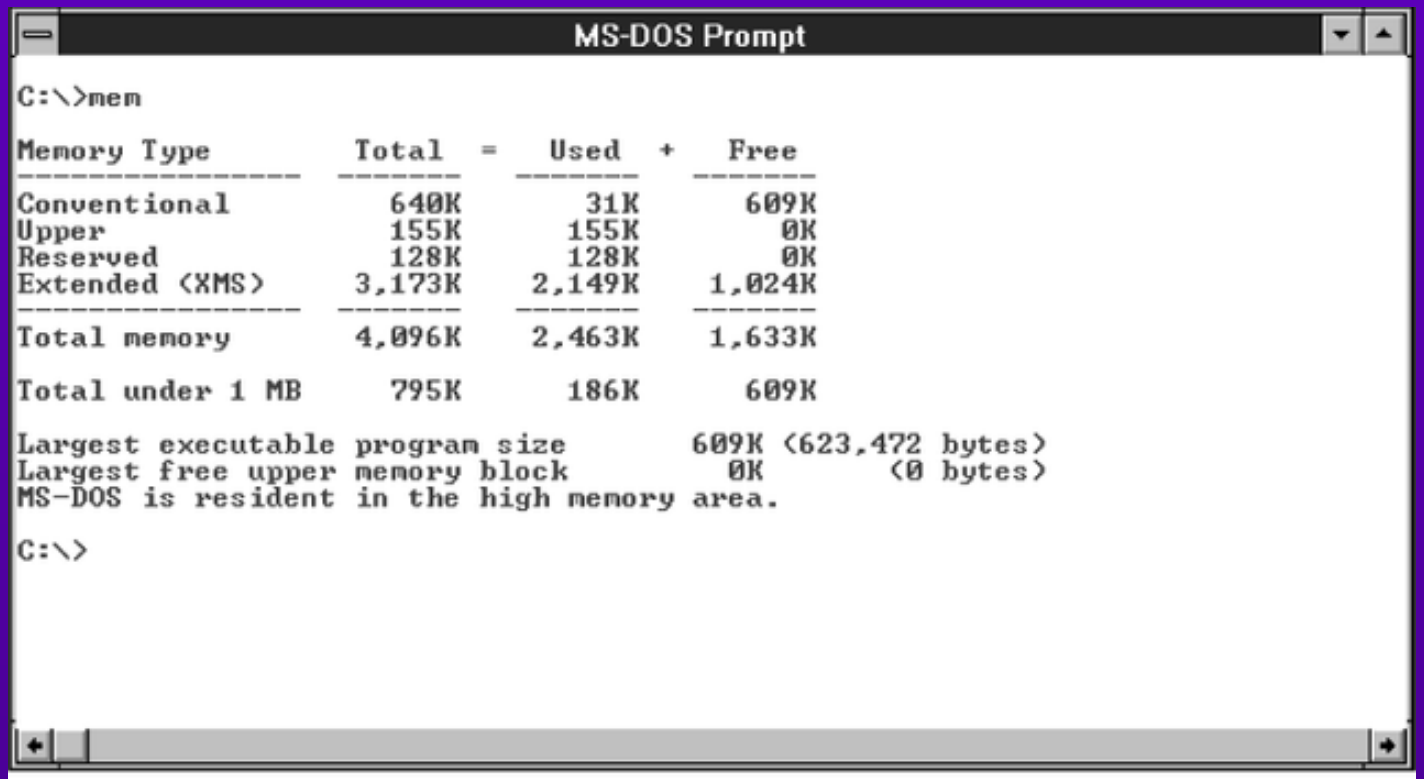


Figure 4-17 MEM report on a PC using upper memory

Memory Reports Using the MEM Command

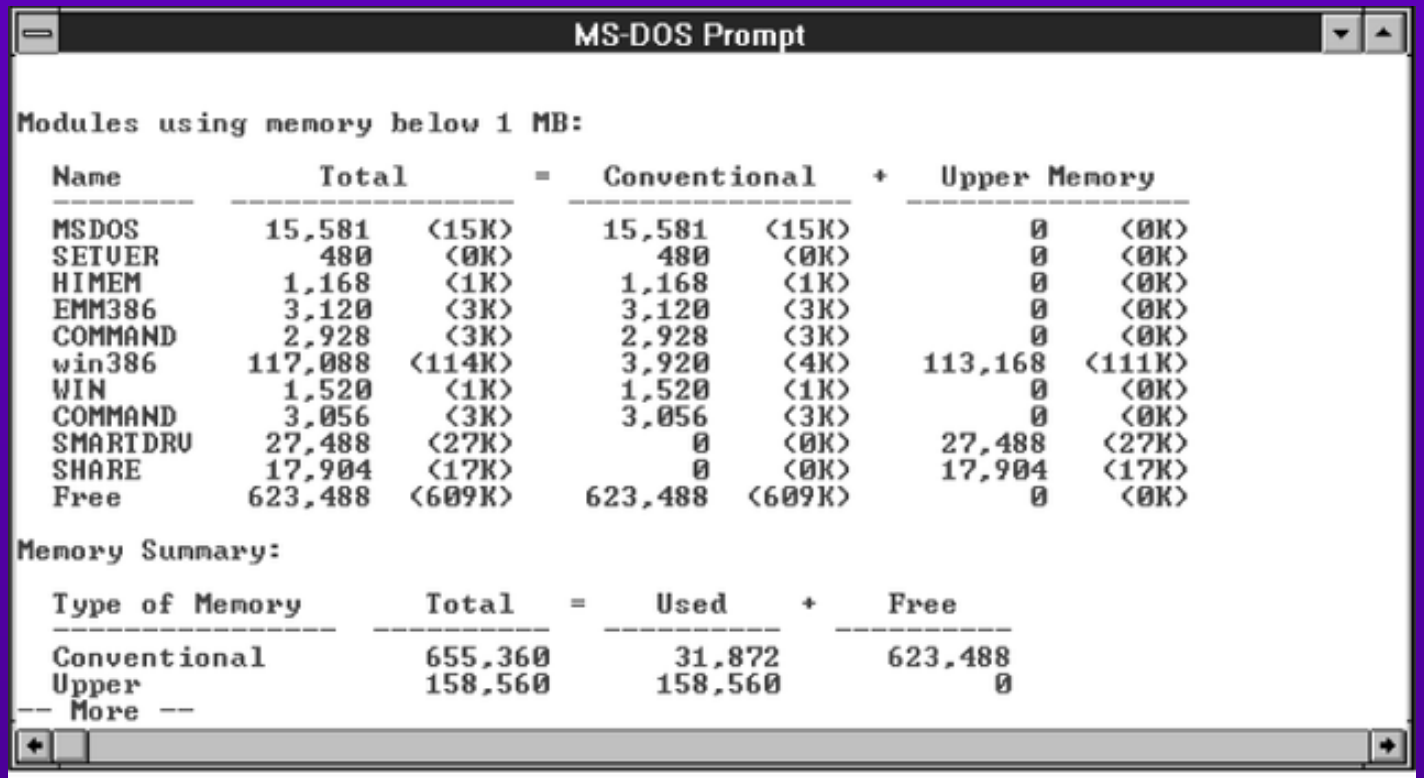
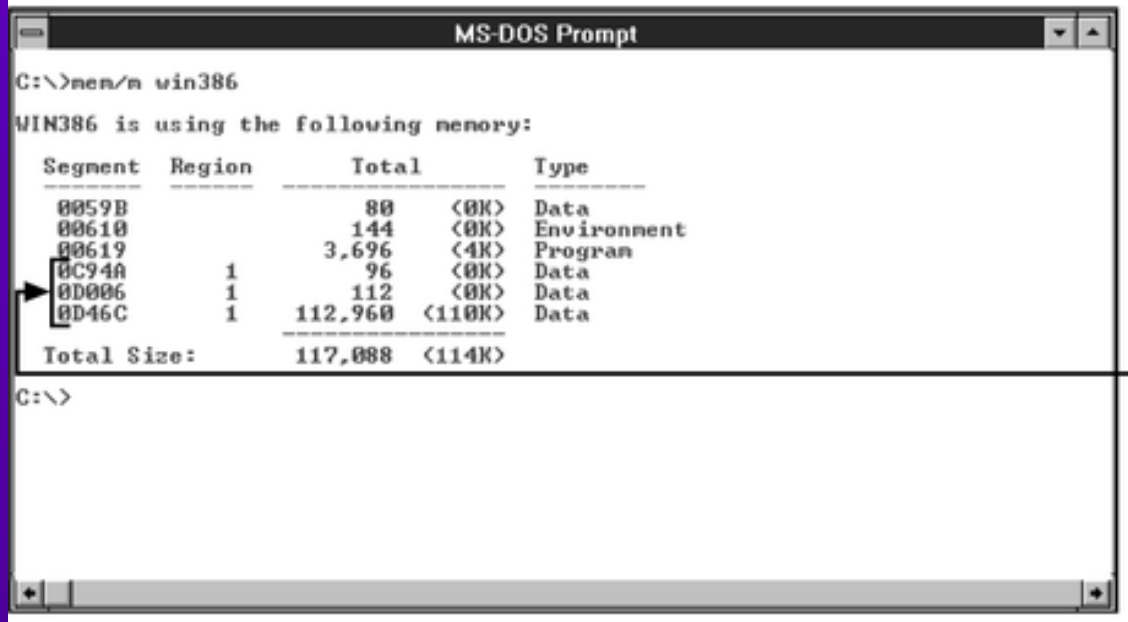


Figure 4-18 MEM/C report on a PC using upper memory

Memory Reports Using the MEM Command



Upper memory addresses

Figure 4-19 How WIN386 is using memory

Using MemMaker with DOS 6+

- A DOS utility that can increase the amount of conventional memory available to DOS-based software applications, by loading drivers and TSRs into upper memory

Managing Memory with Windows 3.x

- Should be running in 386 enhanced mode
  - Allows more than one application to be loaded into memory at the same time
  - Can use virtual memory

Swap Files and Virtual Memory

- Swapping
  - Method of freeing some memory by moving a “page” of data temporarily to a swap file on the hard drive
  - Can later be copied from disk back into memory
- Three ways Windows 3.x uses swap files
  - Temporary files created and used by applications
  - Application swap files
  - Created and used by Windows to serve as virtual memory

Swap Files Used to Create Virtual Memory

- Temporary swap file (Win386.swp)
  - Shrinks and grows as Windows uses it
  - May be located in different locations over the hard drive as it changes in size
- Permanent swap file (386spart.par)
  - Stays at a constant size
  - Continues to occupy same area of hard drive

Optimizing Windows with the Swap File

- Reasons to use permanent swap file
  - Always made up of contiguous clusters of memory
  - Less access time than temporary swap file

How to Change the Swap File

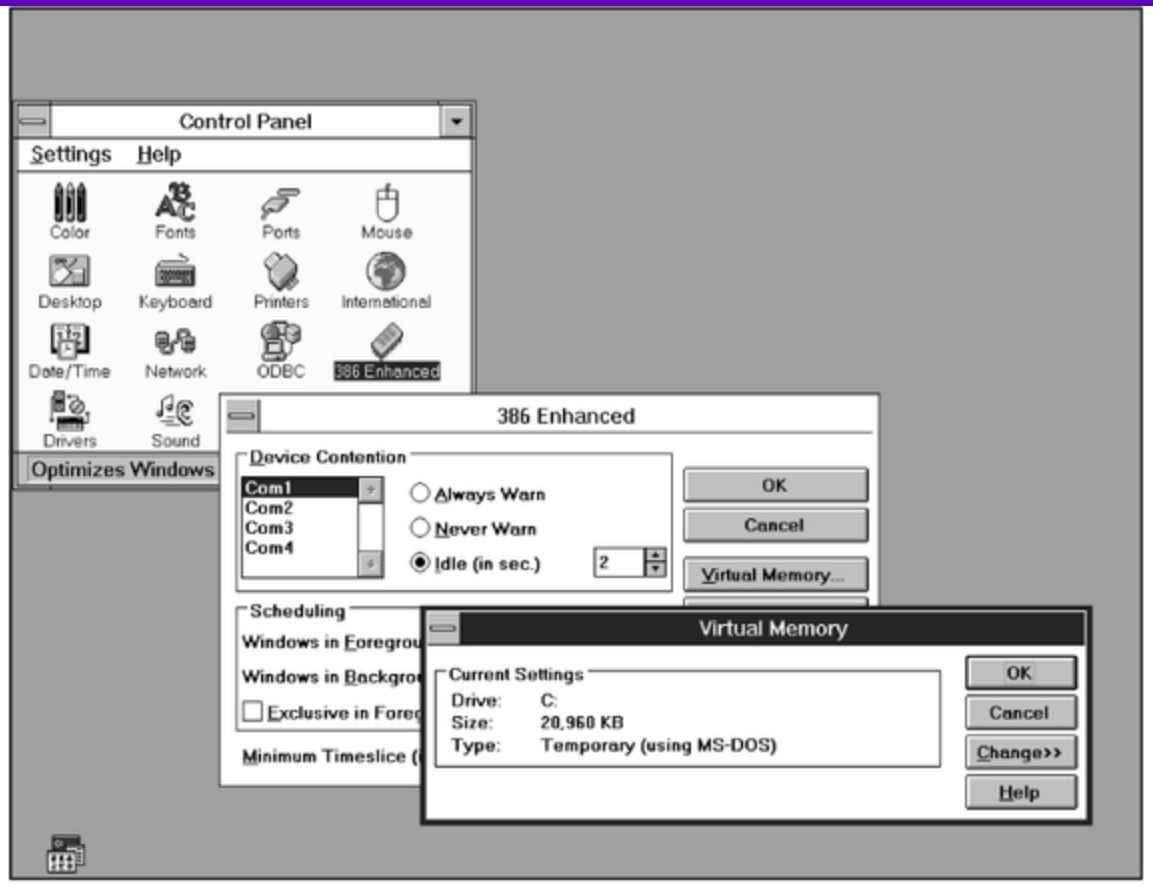


Figure 4-20 The Virtual Memory dialog box

How to Change the Swap File

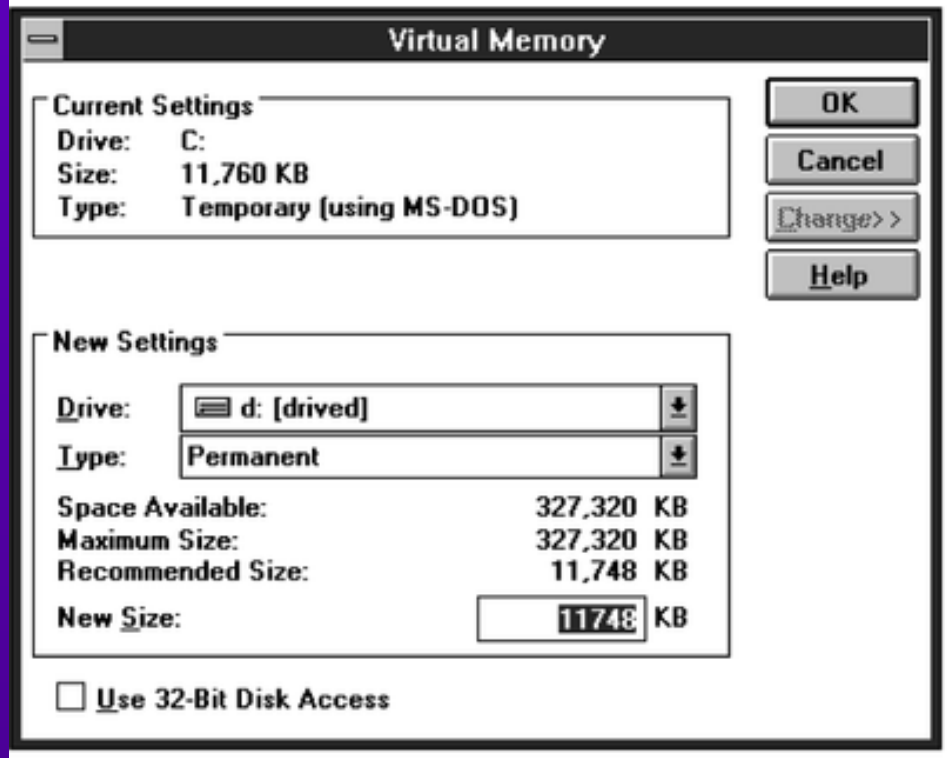


Figure 4-21 Settings to convert the swap file from temporary to permanent

How to Change the Swap File

Figure 4-22 Creating a permanent swap file

How to Change the Swap File

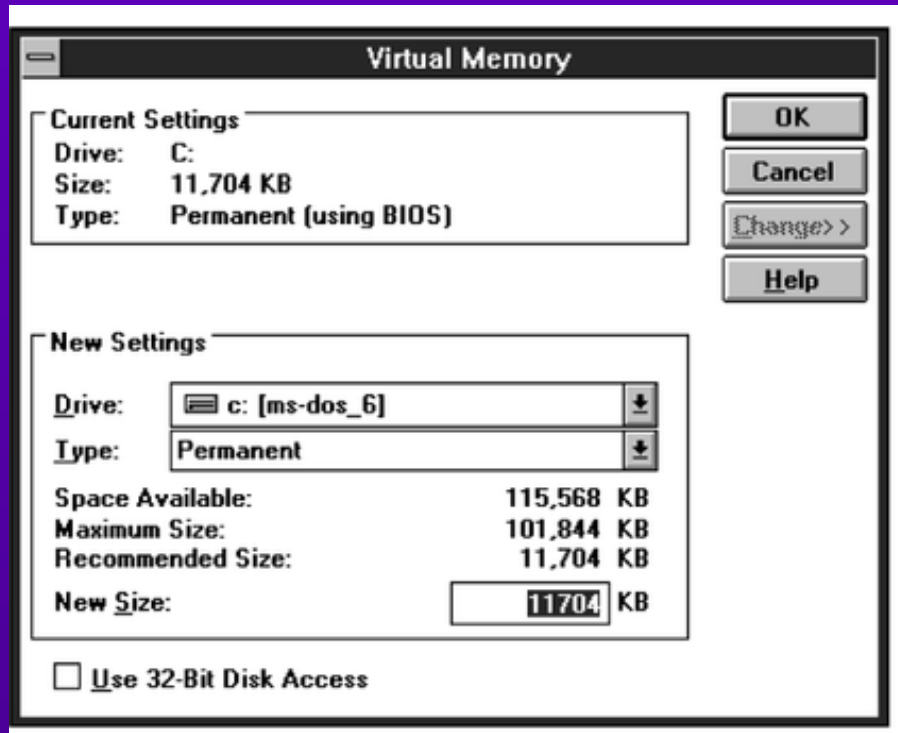


Figure 4-23 Windows recommends that the swap file remain permanent

Managing Memory with Windows 9x

- Improvements in Windows 9x
  - New 32-bit drivers (virtual device drivers or VxD drivers) eliminate need for DEVICE= entries in CONFIG.SYS
  - Frees up more conventional and upper memory because no need for SMARTDRV.EXE or SHARE.EXE

Running DOS Applications Under Windows 9x

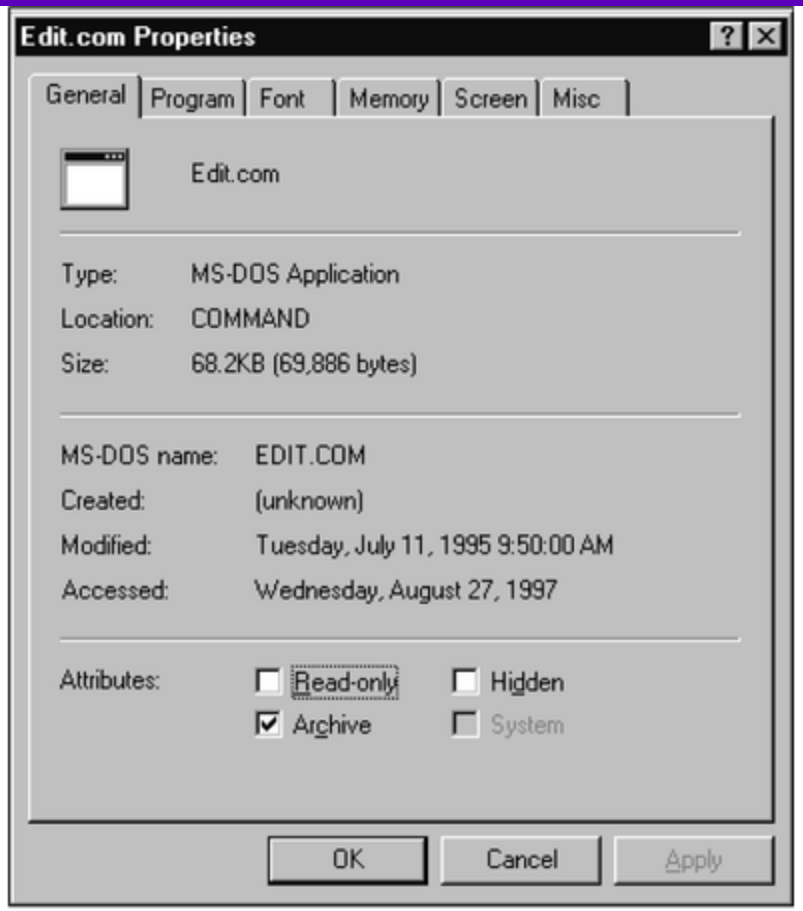


Figure 4-24 Properties sheet for a DOS application

Running DOS Applications Under Windows 9x

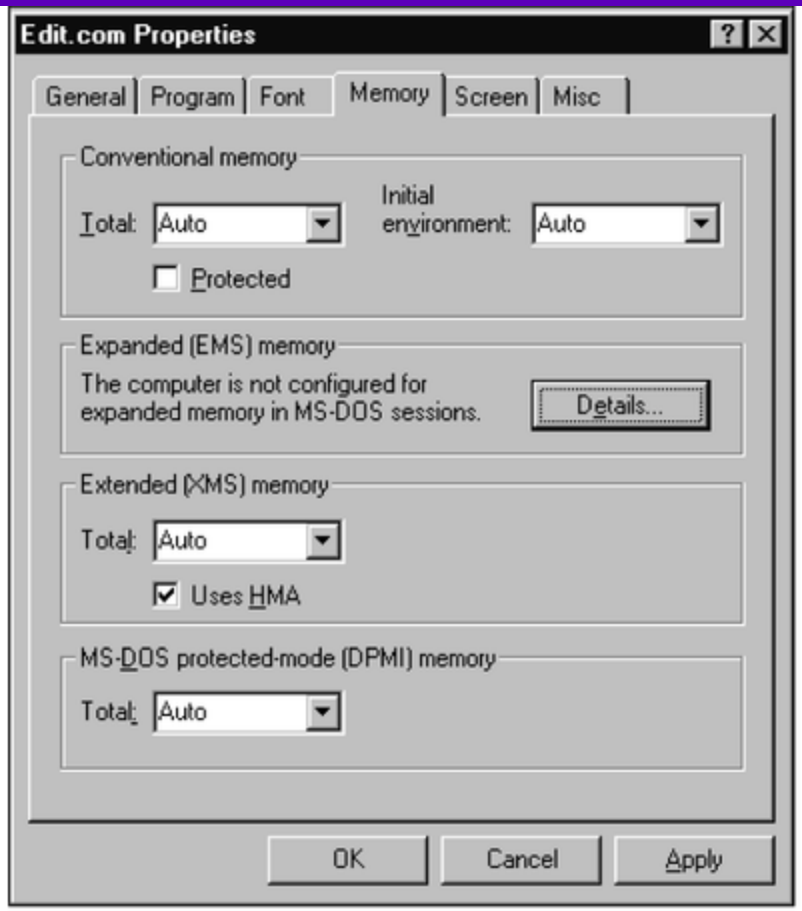


Figure 4-25 Setting up memory for a DOS application running under Windows 9x

Read Mode vs. Virtual Real Mode

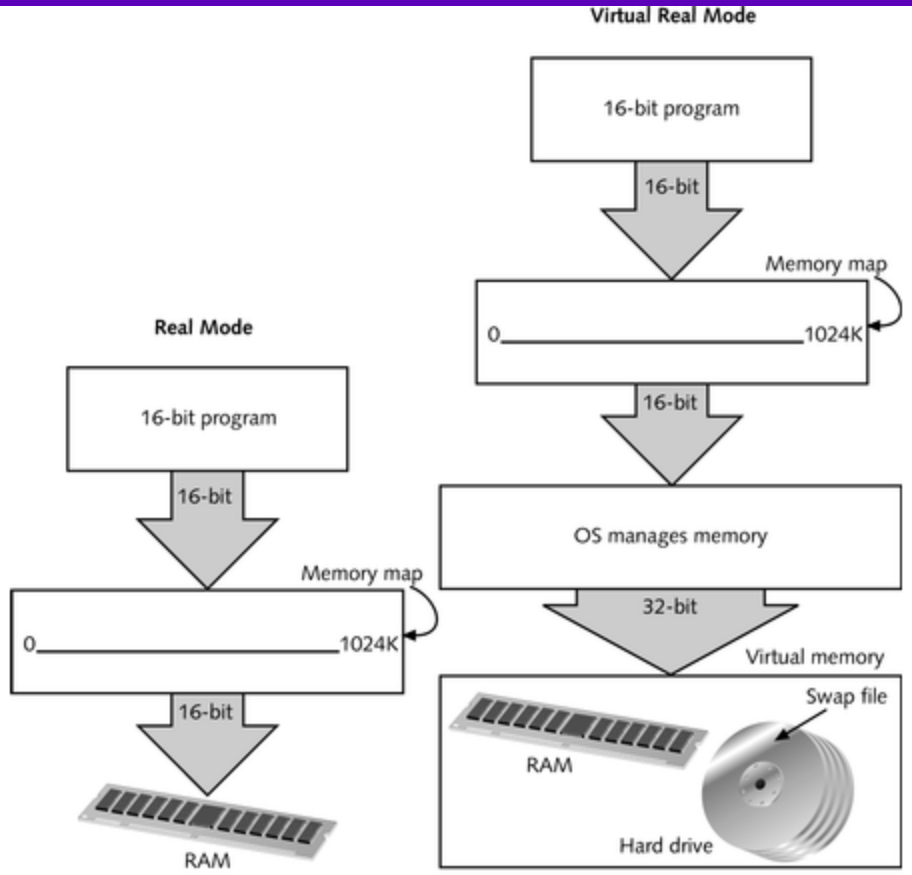


Figure 4-26 Virtual real mode provides "DOS in a box" to a 16-bit application that was written to run in real mode

Virtual Real Mode

- Program “thinks” it is really working in a real-mode environment and that:
  - It is the only program running
  - It has all memory available to it
  - It accesses data using a 16-bit data path

Types of 16-bit Applications

- DOS
  - Expects to run in real mode with no other applications running with them
- Windows 3.x
  - Expects to allow Windows to manage memory for it
  - Expects that other applications might also be running in a cooperative multitasking environment

Running a 16-bit Application in a Real-mode Environment

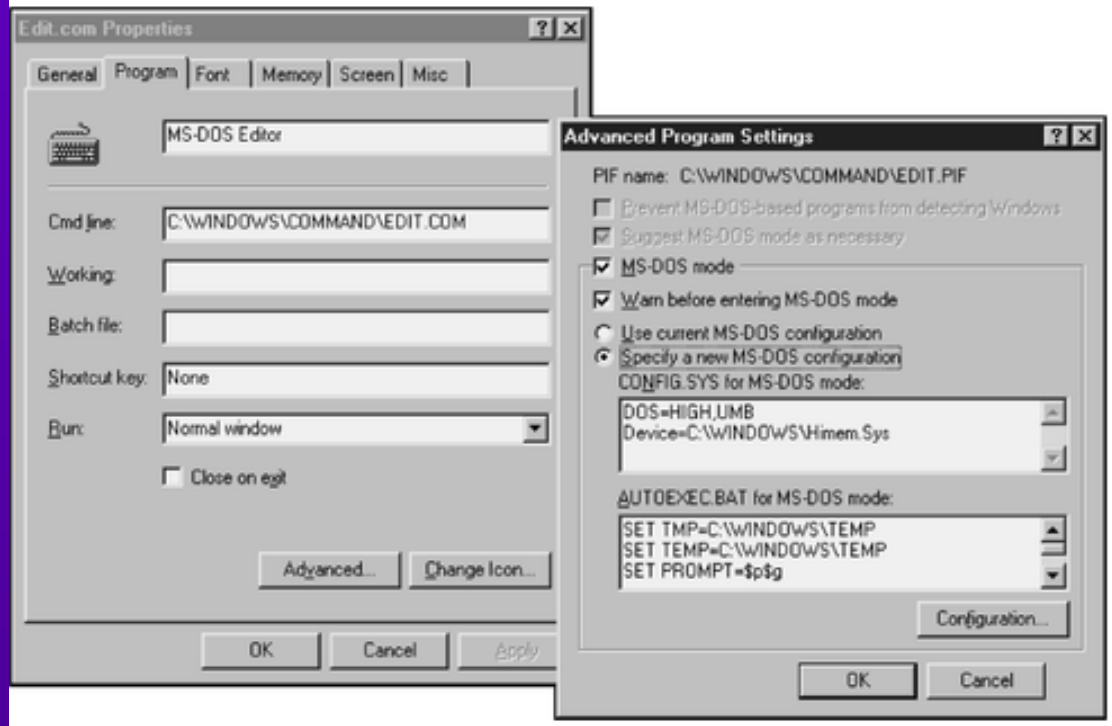


Figure 4-27 Running a 16-bit application in a real-mode environment in Windows 9x can be done using the Advanced Program Settings box

Windows 9x Swap File

- Automates virtual memory management

Figure 4-28 System Properties Performance box in Windows 9x

Windows 9x Swap File

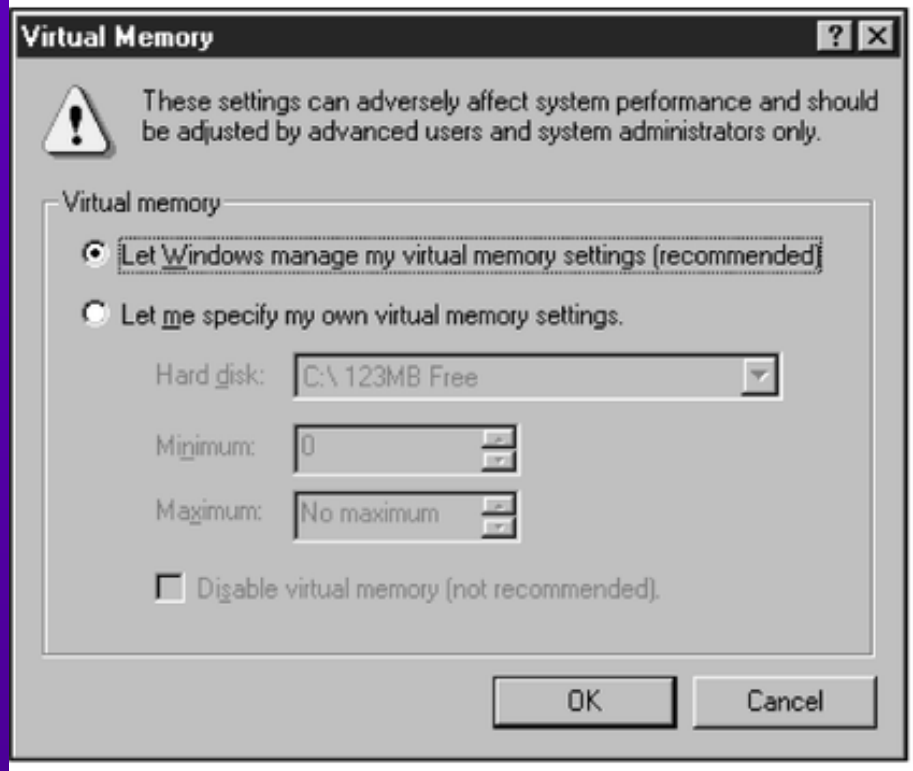


Figure 4-29 Options for managing virtual memory in Windows 9x

The Ultimate Solution: Windows NT

- Memory mapping for Windows NT
  - Is one continuous, linear, 32-bit address space
  - Allows each program and driver using Windows NT access to any part of this memory

Windows NT Memory Management Model

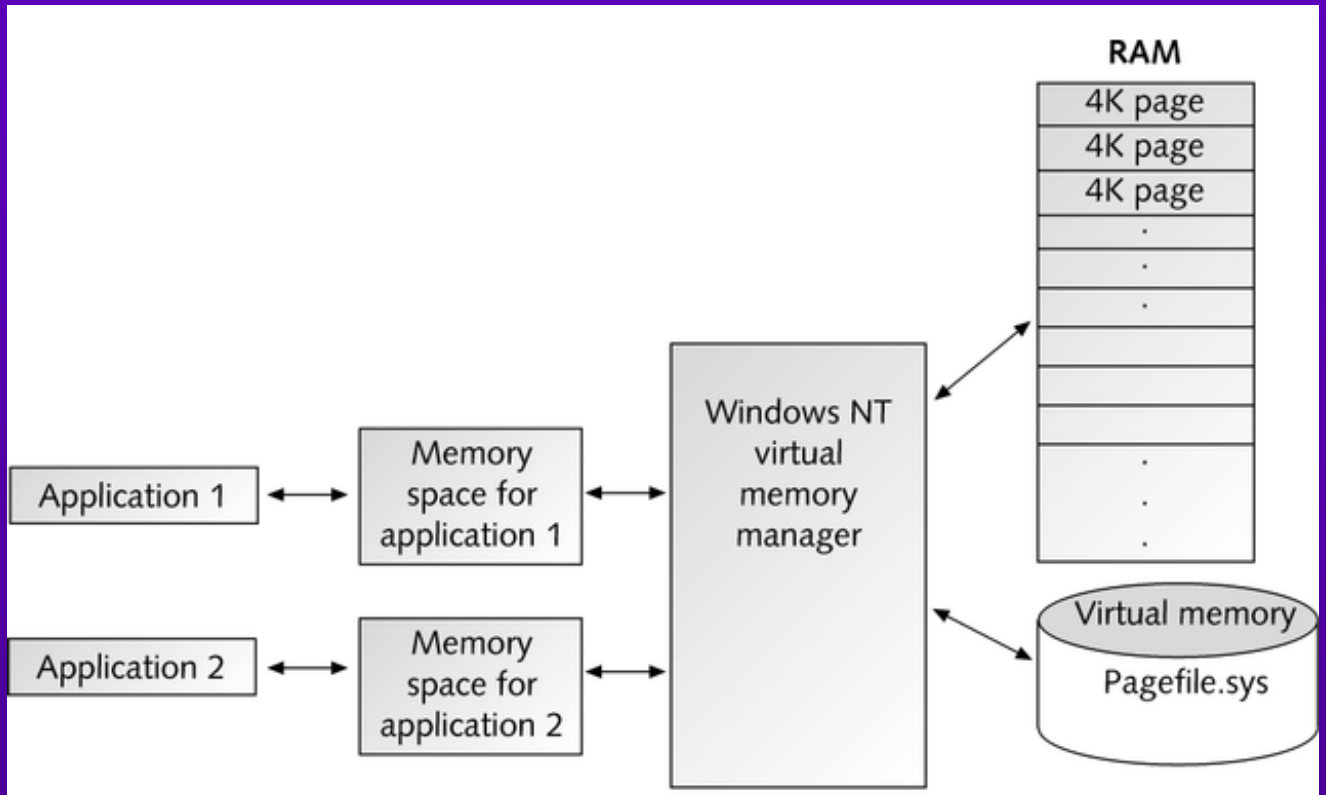


Figure 4-30 Windows NT memory management

Memory Management Troubleshooting Guidelines

- When a TSR will not load high
- When devices do not work or the system hangs
- When two expansion boards are using the same upper memory addresses
- When UMBs and expansion boards conflict

Upgrading Memory

- How much memory do I need?
- How much memory can my computer physically accommodate?
- What increments of memory does the system board support?
- How much additional memory is cost effective?
- What kind of memory can fit on the system board?
- What memory is compatible already with memory installed?

How Much Memory Can Fit on the System Board?

Table 4-3 Memory configurations of a 486 system board

SIMM Size in Bank 1	SIMM Size in Bank 2	Total RAM on System Board
256K	0	1 MB
256K	256K	2 MB
1 MB	0	4 MB
1 MB	256K	5 MB
1 MB	1 MB	8 MB
4 MB	0	16 MB
4 MB	256K	17 MB
4 MB	1 MB	20 MB
4 MB	4 MB	32 MB

How Much Memory Can Fit on the System Board?

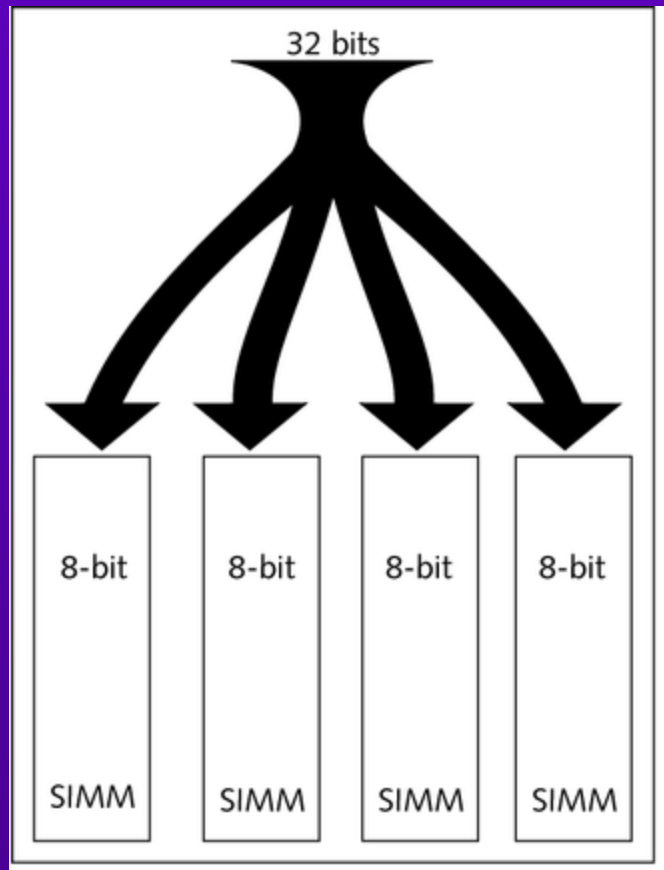


Figure 4-31 One bank on a 486 system board that uses a 32-bit bus and 8-bit, 30-pin SIMMs; each SIMM must hold the same amount of memory

How Much Memory Can Fit on the System Board?

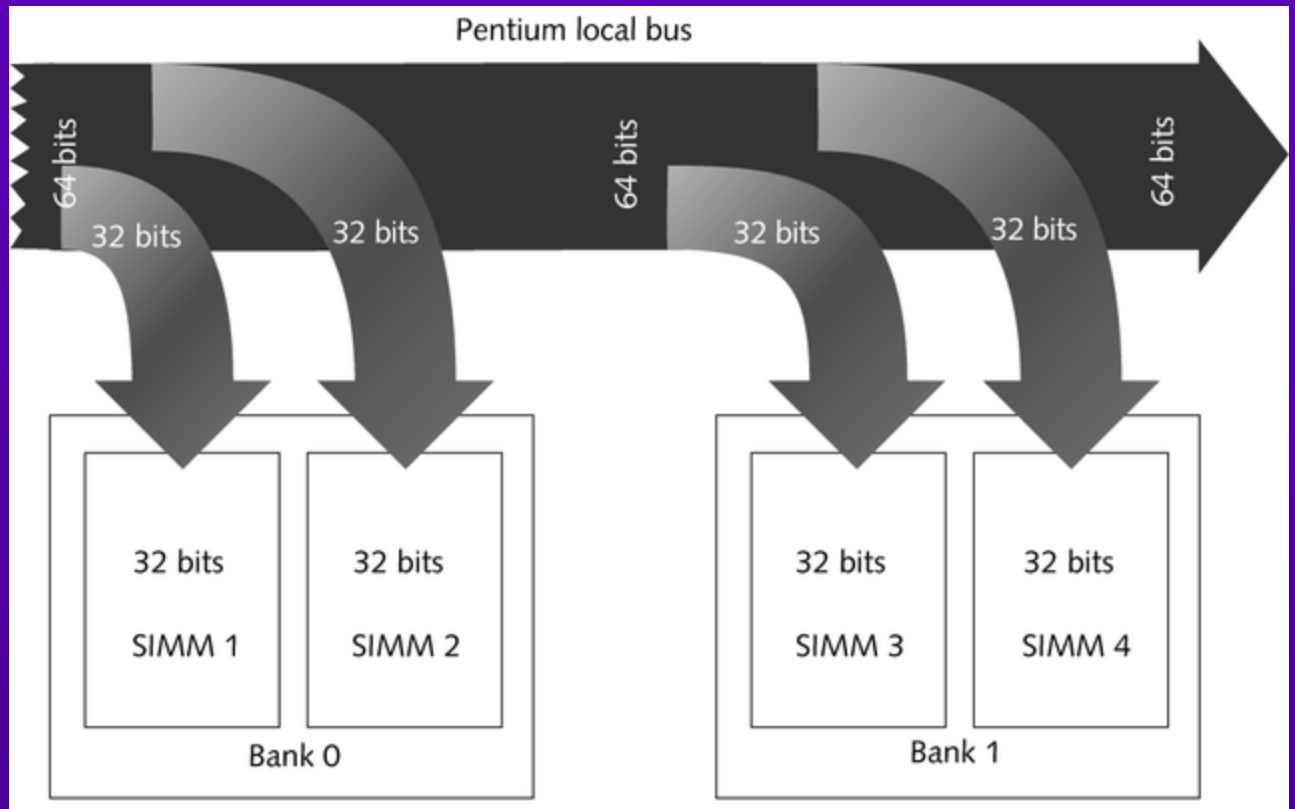


Figure 4-32 A Pentium memory bus is 64 bits wide and requires two 32-bit SIMMs to accommodate the bus width; each 64-bit bank can be used independently of the other

How Much Memory Can Fit on the System Board?

Table 4-4 Memory configurations for a Pentium system board using SIMMs

SIMM Size in Bank 0	SIMM Size in Bank 1	Total Memory
4 MB	0	8 MB
4 MB	4 MB	16 MB
4 MB	8 MB	24 MB
4 MB	16 MB	40 MB
4 MB	32 MB	72 MB
8 MB	0	16 MB
8 MB	4 MB	24 MB
8 MB	8 MB	32 MB
8 MB	16 MB	48 MB
8 MB	32 MB	80 MB
16 MB	0	32 MB
16 MB	4 MB	40 MB
16 MB	8 MB	48 MB

How Much Memory Can Fit on the System Board?

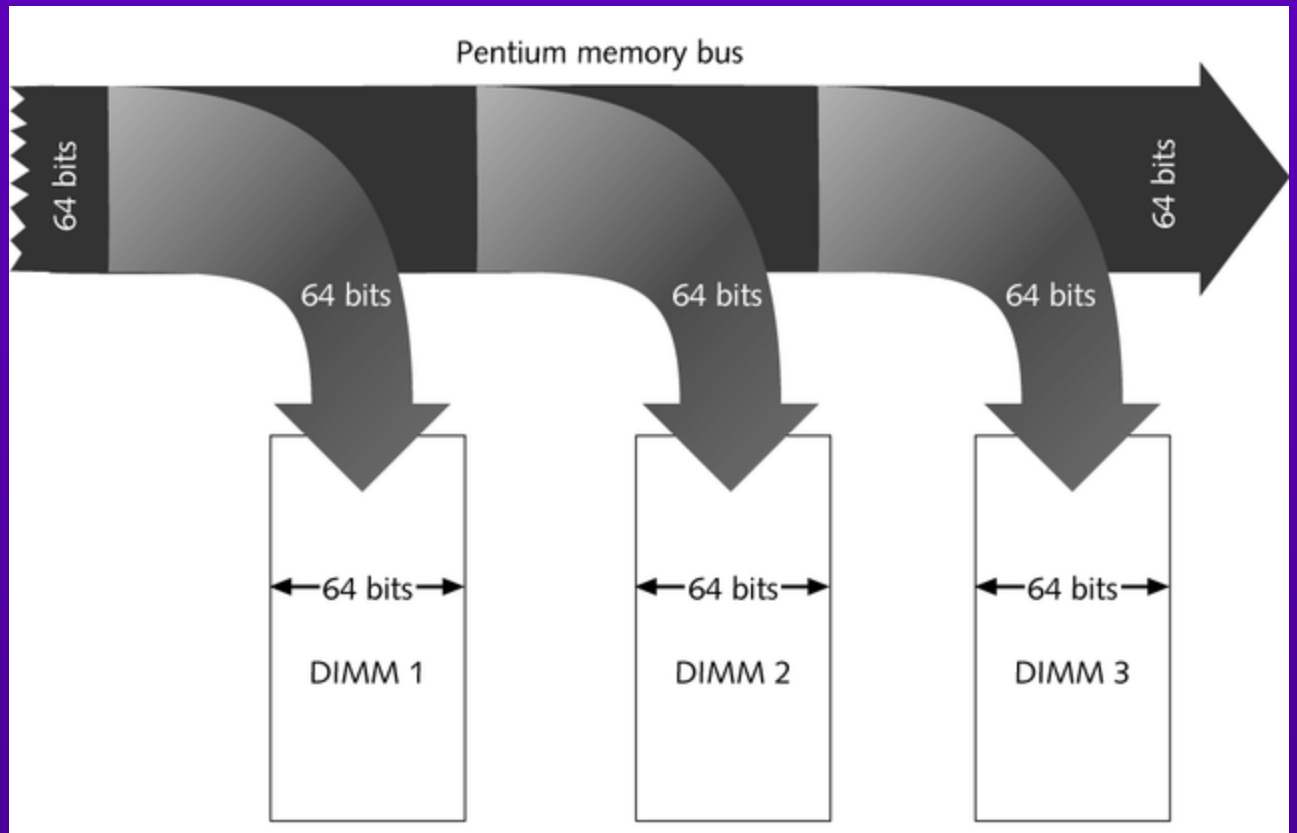


Figure 4-33 Only a single DIMM is needed to fill one bank of memory for a Pentium memory bus; each DIMM can be a different size

Selecting Memory Types

DIMM Location	168-pin DIMM		Total Memory
Socket 1 (Rows 0&1)	SDRAM 8, 16, 32, 64, 128, 256MB	x1	
Socket 2 (Rows 2&3)	SDRAM 8, 16, 32, 64, 128, 256MB	x1	
Socket 3 (Rows 4&5)	SDRAM 8, 16, 32, 64, 128, 256MB	x1	
	Total System Memory (Max 768MB)	=	

Figure 4-34 This table is part of the system board documentation and is used to show possible DIMM sizes and calculate total memory on the system board

Reading Ads About Memory Modules

- Number of pins
- Speed
- Size
- Type of module

Typical Ad for Memory Modules

CALL TOLL-FREE 1-800-555-5555

LOWEST PRICES!

STANDARD MEMORY

GUARANTEED LIFETIME WARRANTY

ITEM#	SIZE	DENSITY	TYPE	SPEED	PIN	PRICE
P56-1002	4MB	4X9(3chip)	Fast-Page Parity	70ns	30 pin	$ 17.99
P56-1003	4MB	4X9(3chip)	Fast-Page Parity	70ns	30 pin	$ 24.99
P56-1022	8MB	2x32	EDO	60ns	72 pin	$ 14.99
P56-1024	16MB	4x32	EDO	60ns	72 pin	$ 39.99
P56-1026	32MB	8x32	EDO	60ns	72 pin	$ 79.99
P56-1027	64MB	16x32	EDO	60ns	72 pin	$ 139.99
P56-1006	8MB	2x32	Fast-Page Non-Parity	70ns	72 pin	$ 26.99
P56-1008	16MB	4x32	Fast-Page Non-Parity	70ns	72 pin	$ 49.99
P56-1010	32MB	8x32	Fast-Page Non-Parity	70ns	72 pin	$ 89.99
P56-1028	64MB	16x32	Fast-Page Non-Parity	70ns	72 pin	$ 164.99
P56-1012	4MB	1x36	Fast-Page Parity	70ns	72 pin	$ 24.99
P56-1014	8MB	2x36	Fast-Page Parity	70ns	72 pin	$ 39.99
P56-1016	16MB	4x36	Fast-Page Parity	70ns	72 pin	$ 54.99
P56-1018	32MB	8x36	Fast-Page Parity	70ns	72 pin	$ 109.99
P56-1030	64MB	16x36	Fast-Page Parity	70ns	72 pin	$ 214.99
P56-1209	16MB	2x64	Burst EDO 3.3v	60ns	168 pin	$ 59.99
P56-1210	32MB	4x64	Burst EDO 3.3v	60ns	168 pin	$ 102.99
P56-1211	64MB	8x64	Burst EDO 3.3v	60ns	168 pin	$ 204.99
P56-1502	16MB	2x64	SDRAM 3.3v Unbuffered	10ns	168 pin	$ 29.99
P56-1504	32MB	4x64	SDRAM 3.3v Unbuffered	10ns	168 pin	$ 39.99*
P56-1506	64MB	8x64	SDRAM 3.3v Unbuffered	10ns	168 pin	$ 79.99**
P56-1508	16MB	16x64	SDRAM 3.3v Unbuffered	10ns	168 pin	$ 214.99
P56-1512	32MB	4x64	SDRAM PC100	8ns	168 pin	$ 56.99
P56-1514	64MB	8x64	SDRAM PC100	8ns	168 pin	$ 114.99
P56-1516	128MB	16x64	SDRAM PC100	8ns	168 pin	$ 224.99
P56-1520	32MB	4x72	SDRAM ECC PC100	8ns	168 pin	$ 79.99
P56-1522	64MB	8x72	SDRAM ECC PC100	8ns	168 pin	$ 154.99
P56-1524	128MB	16x72	SDRAM ECC PC100	8ns	168 pin	$ 299.99

*Price after $10 Mfr's rebate. **Price after $20 Mfr's rebate. Offers expire 4/30/99 Prices subject to change.

Figure 4-35 Typical ad for memory modules

Installing Memory

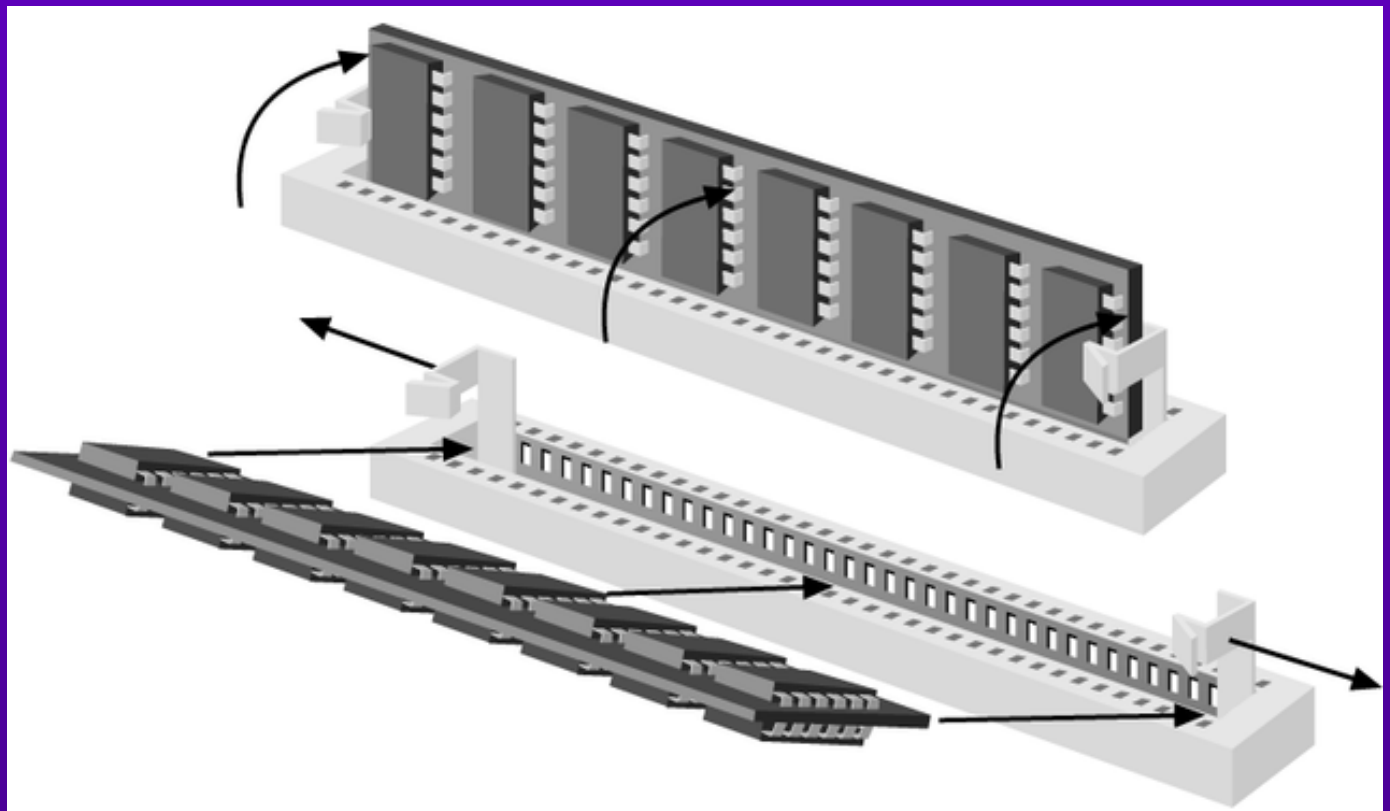


Figure 4-36 Installing a SIMM module

Installing Memory

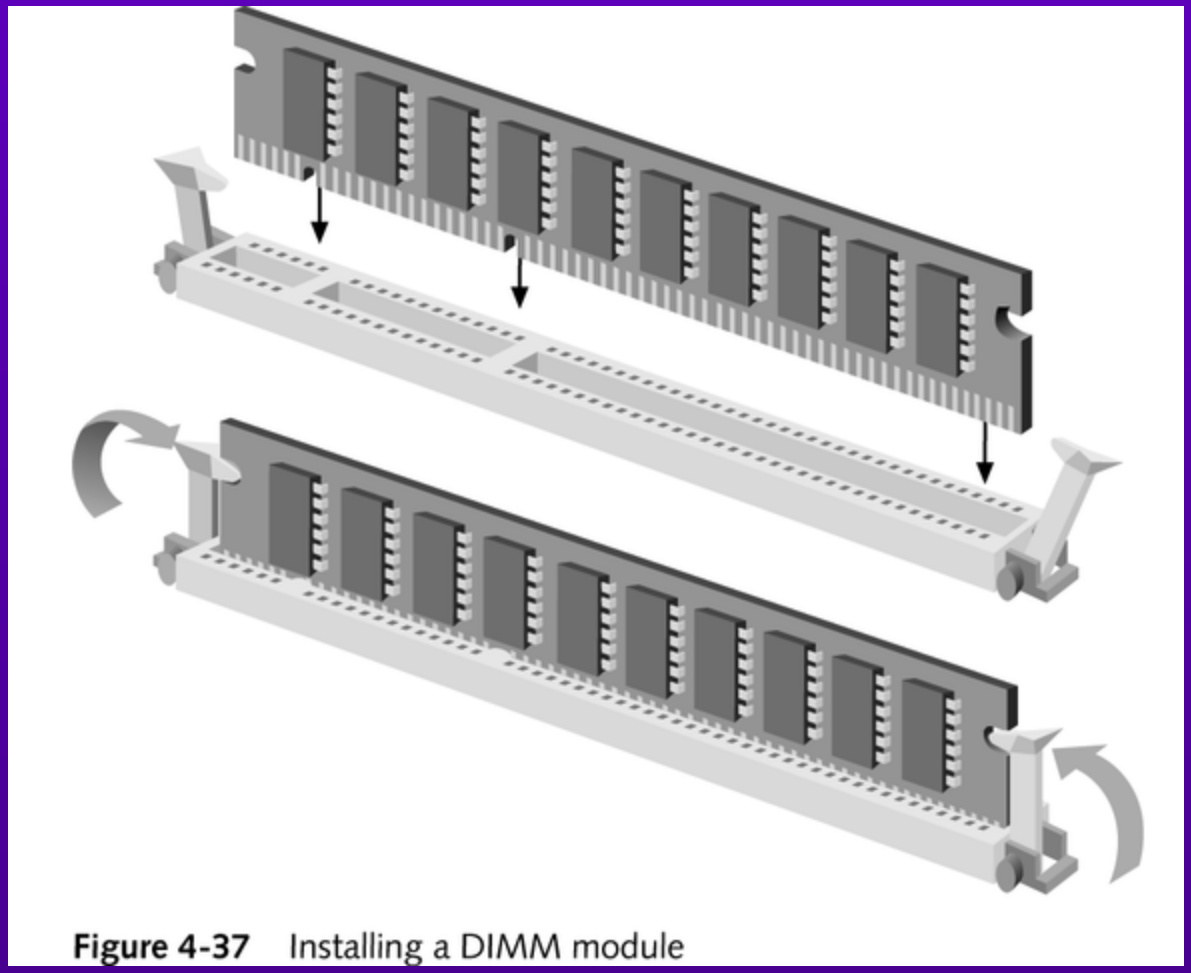


Figure 4-37 Installing a DIMM module

Chapter Summary

- Location of physical memory
- The kinds of memory chips and modules found in a computer
- How the operating system uses the memory located on system boards
- How to manage memory to meet the needs of the software you are using
- How to upgrade the RAM on your computer