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REMOTE BOOTING OF AN OPERATING SYSTEM BY A NETWORK

The present invention relates to a method and an apparatus for remote booting of an operating system through a network. From British Patent Application 2,231,180, it is known to boot a first computer, connected to a second computer through a network, by loading a subsystem of the operating system into the memory of the first computer, the subsystem including the commands enabling file copying, the creation of a directory, disk formatting, and the operation of a connection through the network so that this first subsystem can then be used to transfer all the files of the operating system from the second computer to the disk of the first computer. The method of this patent application has the disadvantage of requiring an initial loading of a subsystem of the operating system into the memory, and then the presence of a magnetic peripheral, such as a hard disk or a diskette reader in the first reader into which the operating system is to be loaded. Such a procedure is especially incompatible with remote booting of terminals, which must be done very fast.

US Patent 4,958,278 also discloses a method for loading data or programs into a plurality of terminals. These terminals are not provided with a disk reader. Once a loading request is sent by one of the stations that has just been turned on, the

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server sends the first frame, waits for acknowledgement, and upon receiving the acknowledgement sends the subsequent frames. If some other terminal sends a loading request in the course of transmission of the frames corresponding to the loading of a first station, then the second station will take into account the frames sent to the first station, by noting in a table the fact that it is missing the first frames received by the first station. Each station must send its acknowledgement after the transmission of one frame. Once all the frames have been sent to the first station, the stations that logged onto the network later receive the first frames, which they had not initially received because they were connected later. In this method, it is the server that memorizes the number of the first frame that a second station in the network receives at the moment that station appears, and that at the end of loading the first station connected sends the other station the frames that it had not been able to receive. This method requires each station to send its own acknowledgement, which requires time to transmit the various acknowledgements for each station, to prevent collisions. This introduces a delay between the end of transmission of one frame and the transmission of the next frame. This delay must either be variable as a function of the number of the station connected, or must be calculated to correspond to the maximum configuration.

However, this method and apparatus permit only a fixed kind

of operation by a predetermined remote booting program that performs the loading of a fixed application once and for all.

One object of the invention is to propose a method for loading terminals that may not include a disk or diskette unit and that makes it possible, for a standard terminal architecture using the standard PC operating system (MS-DOS), to load all the applications or files that may be desired later.

This object is attained in that a method for remote booting by a server of at least one terminal, including a volatile memory (RAM), at least one processor, a telecommunications card enabling connection to the server by a network, the server being provided with telecommunication means and memorization means of sufficient capacity to store the communications protocol, the operating system of the terminals recopied into an image file, its own operating system, and the applications programs, is characterized in that it includes a method of remote loading of a startup program, consisting of transforming the first interruption produced by a terminal following its being powered up into a request for reading an image file memorized in the server.

In another feature, the step of remote booting of the startup program consists of loading the startup (BOOT) sector into the volatile memory RAM, starting the execution of this startup file, transforming the interruptions requesting access to files of nonexistent magnetic peripherals of the terminal into

requests for reading the corresponding image file in the server, by a procedure of coordinate transformation.

In another feature, the procedure of coordinate transformation consists of transforming the coordinates of physical sectors of the files of the magnetic peripherals into a logical chapter numbering of the image file corresponding to the sector of the file called by a sector correspondence table, transmitting to the server the chapter reading request, and sending the chapters of the images files to the set of terminals.

In another feature, the volatile memory RAM of the terminal, after the first remote booting of the startup program, contains a file allocation table (FAT) establishing a correspondence among the diskette number, the head number, the track number, the track sector number, and the file name, and a sector description table (SDT) establishing a correspondence among the diskette number, the track number, the track sector number, and the chapter number of the image file of the server.

In another characteristic, the program for transformation of the interruptions (EMUL INT) is memorized in a nonvolatile memory (PROM) of the telecommunications card.

In another characteristic, the method enables the remote loading of files of the operating system, constituted by the IO.SYS, MSDOS.SYS, CONFIG.SYS and COMMAND.COM files.

In another characteristic, the file allocation table (FAT)

is memorized with eternal status (KEEP FOREVER) in the random access memory RAM, this status indicating by one bit of the word the state of the sector description card.

Another object is to propose a method for remote booting of a plurality of terminals that limits the waiting time of the terminals.

This object is attained in that when a terminal sends a request for a first chapter to the server, the server waits for a period of time T1 before replying, to assure that other terminals will not be having the same request.

In another characteristic, a request for a first chapter by another station arriving before a period of time T2 following the request for the same first chapter by a first station has elapsed is accepted immediately, and the procedure of remote booting of all the stations having sent the requests is reset to 0 for these stations.

In another feature, the server closes the session at the end of a time T3 between the transmission of each chapter and a time T5 between each frame transmission.

In another feature, the server transmits an end of boot frame at a time T4 after the transmission of an end of chapter frame, without any other station having sent a request.

In another feature, the times T1-T5 are parametrizable.

Another object of the invention is to propose a remote

booting method which after the end of remote booting of a first operating system set can also remote boot various applications, either on request of the terminal or by multiaddressing (multicasting).

This object is attained in that the method includes a step of sending specific data frames to the chapters that include the Ethernet address of the receiving stations.

Another object is to permit access to the file loaded into the terminal and for nonexistent files to enable their remote booting.

This object is attained in that the terminal, when executing an instruction to open a file, reads the file allocation table; thus determines the sector and then reads the sector description table to determine the chapter to be looked for, executes the chapter, if the chapter resides in the RAM executed; sends a request for remote booting to the server, if the chapter is absent.

In another feature, the sector description table includes a state byte indicating by one bit the reception of the chapter, by another bit its use, by a third bit the status "KEEP FOREVER", by a fourth bit the number of the segment, by a fifth bit the presence of a fill value, and by a sixth bit a data-specific sector.

In another feature, the terminal includes a state register

for the emulated interruption function, which in the case of the reception of an end of remote boot frame makes it possible to determine, by reading registers DL and AL of the microprocessor (213) of the terminal, whether it is necessary to perform a "load data segment" function or a "shutdown" function.

Further characteristics and advantages of the present invention will become more apparent from reading the ensuing description, taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a schematic view of the entire network enabling the employment of the remote booting method;

Fig. 2 is a schematic illustration of the timing diagram of the exchanges between the server and one or more stations;

Fig. 3 is a schematic view showing the state of the network after loading of the operating system;

Figs. 4A-4C show the constitution of the various frames used in the remote booting method.

Fig. 1 shows a server (1) connected by a telecommunications card (10) to an Ethernet network (3) and through this Ethernet network (3) to at least one first (ST1) and second (ST2) terminal. Each terminal ST1 (21), ST2 (22) is constituted identically by an Ethernet communications card (211), which includes a processor (2110) and a PROM for managing the processor package (2110). This PROM (2110) includes not only the package

management program but also either a program UDP for establishing multiaddress connections with the server, or a program (IP) for establishing single-address connection with the server. The PROM also contains an interruption emulation program 13 and an interruption program 19. The card 211 communicates with the bus of the terminal. The terminal itself includes a microprocessor (213) and a random access memory RAM with a capacity of at least 1 Mb, connected to the microprocessor by the bus. The microprocessor (213) communicates with the telecommunications card (211) by the bus, and the initialization program contained in the read-only memory (ROM) of the station, upon a reinitialization, makes it possible to generate an interruption (19), which is emulated by the program stored in the PROM (2110). This emulation makes it possible to establish a connection with the server, with the aid of the programs UDP or IP. The memory (2110) also contains a remote boot protocol (PROTCHG) and a driver NDIS. As soon as this station is powered up, the interruption emulation program (IT19) brings about the transmission of a frame to the server by the communications protocol UDP or IP, and the server remote boot protocol TCHG replies to this frame by transmitting the file allocation tables (FAT) and sector description tables (SDT) which are stored in the cache diskette CD of the random access memory RAM (212). After this transfer and after the server has sent a program BOOT for

initializing the station, the station executes this program, and as soon as it encounters a request to read a nonexistent file in its RAM, it generates an interruption (IT13) to request access to the magnetic peripherals that are nonexistent at that station. This request for access to the magnetic peripherals (INT13) causes the execution of an emulation program, which brings about the establishment of a link with the server (1) by requesting the server to send a chapter corresponding to the name of the file the opening of which has been requested. The file allocation table (FAT) makes it possible to establish a correspondence between the file name diskette number, the head number, the track number, and the track sector number where the file is located, at a station that has a diskette or disk, and the table (SDT) makes it possible to establish a correspondence between the sector number and the chapter number to be requested from the server. Following this request, the server administrator program (ADM), in an image file (IMA), prepares the chapter requested by the station. In Fig. 1, the image file includes the MS-DOS operating system files, which are constituted by the IO.SYS, MS-DOS.SYS, CONFIG.SYS, and COMMAND.COM files. Each time the MS-DOS operating system is executed, the station will request the opening of the files necessary for its function, and this file opening will bring about a chapter request until all the files necessary for system function have been loaded, to enable normal

function of the terminal. At that moment, the system configuration, assuming that only the terminal ST1 is in operation, corresponds to that shown in Fig. 3, in which it can be seen that the volatile memory (212) has been loaded with the IO.SYS, MS-DOS.SYS, CONFIG.SYS, COMMAND.COM and NETFLOP.DOS programs, this last program being intended to handle the management of the communications card in such a way as to optionally permit later remote booting in response to specific sector or chapter requests. The remote booting protocol employed is shown in further detail in Fig. 2, in which it can be seen that the station (1) sends an initializing request (BD), to which the server responds with a "BOOT REPLY" message (BR). Following that response, the station sends the chapter request, in this case for the first chapter, by sending a "start chapter 1" (SC1) frame, to which the server responds by the request (ARPD) for the Ethernet address, in the case of a multi-addressing communication, and the station furnishes this information by the response (ARPR). Following that response, the server sends a sector description table frame for chapter 1 (SDTC1), and then at the end of a time T5 sends the data of chapter 1 (DC1), which may be sent in a plurality of frames, always with an interval of time T5 between each frame. The server waits for a period of time T1 between the "start chapter 1" (SC1) message requesting starting of remote booting and the response message requesting the

address. This time interval enables other stations, whose startup took place concomitantly, also to send their "start chapter 1" (SC1) messages, resulting in immediate acceptance by the server. At the end of transmission of chapter 1, the station, if it finds an error, sends an error message SDTE relating to a portion of chapter 1, and in that case the server resends the frame SDT of chapter 1 (SDTC1) and the specific data for that chapter (SDC1) that have not been received. At the end, the server sends an "end chapter 1" frame (EC1), and the station executes this chapter 1 received, in order in the course of execution to discover whether the file corresponding to the chapter received requires calling up another file. That triggers a request for another chapter n via a "start chapter n" frame SCn. When it receives this request, the server waits for a period of time T3 before sending the frame SDTCn constituting the sector description table of the chapter n and the frame DCn for the data of this chapter. As before, if the station sends an error frame relating to the chapter n (SDTECn), the server will send the frame of the sector description table of the chapter (SDTCn) and the specific data for this chapter SDCn that were not received properly. Once the station receives the end of chapter frame (ECn), the chapter received is executed, and if there is any error in the data, a data error frame for chapter n (DECn) is sent, in order to obtain the transmission of a data frame for

chapter n (DCn) on the part of the server. Once again, transmission is completed by an end frame for chapter n (Cn). The server then waits for a period of time T4, during which, if it receives no complementary request, it sends an "end remote boot" frame (ERB). In the case where the server is connected to a pluraility of stations, and when a second station 2 ST2 sends a chapter 1 request SC1 by connecting itself to the network during a time interval T2 following the connection of a first station, the request of this second station is immediately accepted, by cancelling the procedure of remote booting the first station and beginning the procedure again from 0 for the set of both stations. This procedure makes it unnecessary to have to wait for the end of remote booting of one station 1 to remote boot a station 1, or again to avoid having a memory at the server level that manages the chapters that have not been received in order at the end of remote booting to request the remaining chapters to be received, as in the case of US Patent 4,958,278.

Each frame sent in the course of the remote booting sequence shown in Fig. 2 has a specific configuration corresponding to that shown in Figs. 4A-4C. Hence the "start chapter" frame (SC), by its first two bytes, makes it possible to indicate the frame type and to let the server know that this is a "start chapter" frame, requesting the transmission of a chapter; by the next 12 bytes, to define the name of the volume in which

the chapter to be sent is located, and by the next two bytes to define the identifier, that is the number of the chapter in ASCII code; and by the next two words to define the Ethernet address (IP station) of the station.

In the discussion that follows, information that is identical and has the same format in the other frames will not be described again.

The sector description table frame SDTC of the chapter also contains the following information: type of frames, name of the volume, identifier, the information defining the mask of the frame formed at one byte and indicating, with the bits A1, the frame number pertaining to this formation SDTC. A supplementary byte defines the maximum mask of the frame, by setting all the bits to "1"; the next two bytes define the first data segment, and the next two other bytes define the second data segment, if any. Two supplementary bytes define the shift where the next cards in the sector description table will be implanted, and two supplementary bytes define the number of following cards. The cards are defined in eight bytes each and, as shown by the SDC card, have the sector number in two bytes, the pseudonym of the sector in two other bytes, the shift in the diskette cache in the next two bytes, the fill value in one byte, and the state of the card in another byte, defined by the bit 7 at "1", the logical value to indicate that the sector has been received, the bit 6 at

"1" to indicate that the sector has been used, the bit 5 at "1" to indicate that the sector should be kept forever, the bit 4 at "1" to indicate the segment number, the bit 3 at "1" to indicate a fill value, and the bit 0 at "1" to indicate the data specific to the sector.

The SDT error frame (SDTE), like the following frames, is constituted by information on the type of frame, volume name, identifier, Ethernet address of the station, and the mask of the frame SDTC. The specific data chapter frame (SDC) also includes the information, frame type, volume name, identifier, shift of the first card, shift of the tenth card, an Ethernet address in six bytes defining the address of the station, and the data to be sent, in 512 to 1024 bytes.

The data error frame (DE) also includes the frame type, the volume name, the identifier, information over two bytes indicating the number of missing sectors, and in two other bytes, for each missing sector, the number of the missing sector.

The end of chapter frame EC and the end remote boot frame (ERB) include the frame type and the volume name.

The specific sector request frame SSD also includes the frame type, the volume name, the identifier, and the number of the specific sector requested in two bytes.

The frame SSR, in addition to the above information, includes the data in 512 bytes.

The interruption emulation program 13, by way of the status register of the emulated functions, modifies the information contained in the registers of the processor (213) of the station in accordance with the following table:

0	reset	reset the "carry" flag (NY) to 0
1	disk_status	samples the diskette status ("read" function) and reset carry (NY)
2	read	see description above
3	write	return "write protect" code and carry error (CY)
4	verify	reset carry (NY)
5	format	set carry error (CY)
8	parameters	sample the diskette parameters and reset carry (NY)
d	special	special remote boot features. (see "status of TCHG after receiving end_remote_boot - with NETFLOP") - with registers DL = 0, AL = 0, this involves the "change data segment" function between the PROM and NETFLOP - with registers DL = 0, AL = 1, it involves the function of shutting down the PROM, or "shutdown".

15	read_dasd	return code "change_line avail." and reset carry (NY)
16	change_line	return code "not active" and reset carry (NY)
17	set_dasd	return code "OK" and reset carry (NY)
18	set_media	return code "write protect" and carry error (CY)

All the other function codes return a return code 01.

Hence it can be confirmed that in the case of the special function represented by the code including between 9 and 15, the registers DL and AL of the microprocessor are to be loaded with logic values that will indicate either a change of segment or the function of PROM shutdown. The other functions emulated make it possible to modify the bits (CY) and (NY) of the state register of the microprocessor.

When the CONFIG.SYS file shown in Fig. 3, containing the PROTMAN.DOS, ELNKII.DOS, NEMM.DOS and TCPDRV.DOS files, which respectively assure the functions of protocol management, card driver, memory management, and resident portion of the communications program, have been loaded and when the entire operating system as well as the NETBIND.EXE program have been loaded, the server sends an "end remote boot" frame (ERB), by which it indicates to the PROM that all the programs have been

loaded, and the remote boot protocol contained in the PROM terminates this remote booting by several actions, which consist of starting the execution of the NETBIND program which uses the program ELNKII.DOS to access the network; this program NETBIND starts the execution of NETFLOP, which enables loading the data segment and recovering the context of the stoppage managed by the PROM. NETFLOP also brings about a normal shutdown of the PROM, with reset of the network card and restoration of the IRQ5 vector to the old BIOS vector, and deinstallation of the manager of the programmable timeouts of the remote booting process. This shutdown causes the management of the interruptions, and in particular of the interruption 13, to change over from the PROM to the NETFLOP program. This new management makes it possible to have a parametrizable behavior different from that fixedly defined by the PROM. The management of INT13 by the PROM is valid as long as the shutdown has not been done. After the shutdown, the interruption 13 of the PROM calls on either the interruption vector 13 of NETFLOP or the old BIOS vector. This shutdown is done by executing the following sequence, written for a microprocessor (213) of the Intel 386 or 482 type, and its transposition to other microprocessors is within the competence of those skilled in the art.

```
push    ds - send data segment ds to the
        register stack
push    ax - send registers AH and Al constituting
        ax to the stack
xor     ax, ax - exclusive-or for ax
mov     ds, ax, moving ax --> dx
mov     ax, word ptr ds:[4a2h] - moving the
        contents from the address determined by
        the contents of ds + 4a2h to ax
mov     ds, ax - moving ax to ds
cmp     di, 0 - comparison of the register di with
        the value 0
pop     ax extraction from the register ax
jne     not_ours if di is not equal to zf = 0 skip
        to label "not ours"
cmp     ah, 19h comparison of 19h with the high
        portion of ax
jae     not_ours skip to "not ours" if ah above 19h
        => CP = 0
test    boot_state, SHUTDOWN
jnz     another_story skip to "another story" if
        not equal to 0 +> zf = 0 (if boot state =
        SHUTDOWN)
push    es - send to the stack of register es
```

```
                pusha   save the eight general registers in the
                        stack
                mov     bp, sp - move SP --> BP
                mov     si, ax - move AX __> SI
                shr     si, 8 - shift logical right by 8; get rid
                        of al
                shl     si, 1 - shift to the left by 1;
                call    cs:dispatch[si]-calling the contexts of
                        dispatch indexed by si
                call    store_status - routine store-status call
                popa    extraction of the eight general registers
                        from the stack
                pop     es - extraction from the register es
                pop     ds - extraction of the data segment from
                        the register
                iret    return form interrupt
not_ours:
                pushf   send flags to the stack
                call    dword ptr save_13; old vector (BIOS)
                pop     ds - data segment extraction
                retf    2                       ; because of carry
                        flag
```

```
another_story:
                pushf
                call    dword ptr new_it_13; netflop vector
                pop     ds
                retf    2                       ; because of carry
                        flag
floppy endp
```

The management of INT13 by NETFLOP calls on the parameters "KEEP FLOPPY" and "KEEP CACHE" stated in a protocol point INI file, which as a function of their states bring about the following function:

KEEPCACHE = YES

KEEPFLOPPY = YES

- INIT13h Looks for the sector in the diskette cache. If the sector is not there or is no longer there, a "specific sector" request is generated to the server TCHG. The server directly accesses the diskette (the one whose FAT and main directory have been sent to the station must imperatively be inserted into the server reader) and replies to the station with a "specific sector reply" (SSR) frame addressed by Ethernet multicasting but including, in the protocol portion of the TCHG, the address IP of the addressee station. The stations filter

this field on receiving such a frame.

Accordingly, a miniature file management remains available for the station, after the end of remote booting.

KEEPCACHE = YES

KEEPFLOPPY = NOS

- INIT13h Looks for the sector in the diskette cache. If the sector is not there or is no longer there, a "sector inaccessible for reading" code is sent to the system.

- The cache remains active in memory.

KEEPCACHE = NOS

KEEPFLOPPY = YES

- A "specific sector" request is generated to the server TCHG. The server directly accesses the diskette (the one whose FAT and main directory have been sent to the station must imperatively be inserted into the server reader) and replies to the station with a "specific sector reply" frame addressed by Ethernet multicasting but including, in the protocol portion of the TCHG, the address IP of the addressee station. The stations filter this field on receiving such a frame.

Accordingly, a miniature file management remains available for the station, after the end of remote booting. (See performance, constraints linked with changing the diskette).

- The cache is inactive, thus freeing the memory for the applications.

KEEPCACHE = NO

KEEPFLOPPY = NO

- INIT13h A return code "sector inaccessible for reading" is sent to the system.

- The cache is inactive, thus freeing the memory for the applications.

The "KEEPCACHE = YES" parameter assumes that the memory range used by the CACHE does not threaten to conflict with a DOS application.

Example:

If the choice of the segment CACHE is 7000H, an application using this segment will overwrite the data of the cache, presenting a very major risk of system blockage.

Conversely, the segments 0D000h remain available for the cache at any moment whatever (outside any use of paginated memory managers (EMS) certainly using this same memory range).

Note: the segments 0D000h and/or 0E000h, if they are used, are not freed after the "end remote_boot" has been received; that is, specifically:

- upon reception of the SDT of chapter 1, after recognition of the job segments 0D000h and/or 0E000h, these same segments are validated.

- upon reception of "end_remote_boot", these segments are not invalidated.

Further modifications within the competence of one skilled in the art are also part of the spirit of the invention.

* C L M S *

CLAIMS:

1. A method for remote booting by a server of at least one terminal, including a volatile memory (RAM), at least one processor, a telecommunications card enabling connection to the server by a network, said server being provided with telecommunication means and memorization means of sufficient capacity to store the communications protocol, the operating system of the terminals recopied into an image file, its own operating system, and the applications programs, characterized in that it includes a method of remote loading of a startup program, consisting of transforming the first interruption produced by a terminal following its being powered up into a request for reading an image file memorized in the server.

2. The method of claim 1, characterized in that the step of remote booting of the startup program consists of loading the startup (BOOT) sector into the volatile memory RAM, starting the execution of this startup file, transforming the interruptions requesting access to files of nonexistent magnetic peripherals of the terminal into requests for reading the corresponding image file in the server, by a procedure of coordinate transformation.

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3. The method of claim 2, characterized in that the procedure of coordinate transformation consists of transforming the coordinates of physical sectors of the files of the magnetic peripherals into a logical chapter numbering of the image file corresponding to the sector of the file called by a sector correspondence table, transmitting to the server the chapter reading request, and sending the chapters of the images files to the set of terminals.

4. The method of one of claims 1-3, characterized in that the volatile memory RAM of the terminal, after the first remote booting of the startup program, contains a file allocation table (FAT) establishing a correspondence among the diskette number, the head number, the track number, the track sector number, and the file name, and a sector description table (SDT) establishing a correspondence among the diskette number, the track number, the track sector number, and the chapter number of the image file of the server.

5. The method of claim 2, characterized in that the program for transformation of the interruptions (EMUL INT) is memorized in a nonvolatile memory (PROM) of the telecommunications card.

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6. The method of one of the foregoing claim, characterized in that it enables the remote loading of files of the operating system, constituted by the IO.SYS, MSDOS.SYS, CONFIG.SYS and COMMAND.COM files.

7. The method of claim 4, characterized in that the file allocation table (FAT) is memorized with eternal status (KEEP FOREVER) in the random access memory RAM, this status indicating by one bit of the word the state of the sector description card.

8. The method of one of the foregoing claims, characterized in that when a terminal sends a request for a first chapter to the server, the server waits for a period of time T1 before replying, to assure that other terminals will not be having the same request.

9. The method of one of the foregoing claims, characterized in that a request for a first chapter by another station arriving before a period of time T2 following the request for the same first chapter by a first station has elapsed is accepted immediately, and the procedure of remote booting of all the stations having sent the requests is reset to 0 for these stations.

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10. The method of one of the foregoing claims, characterized in that the server waits for a period of time T3 between the sending of each chapter and a time T5 between each frame transmission.

11. The method of one of the foregoing claims, characterized in that the server closes the session at the end of a time T4 after the sending of an end of chapter frame, if no other station has sent a request.

12. The method of one of the foregoing claims, characterized in that the times T1-T5 are parametrizable.

13. The method of one of claims 1-7, characterized in that it includes a step of sending chapter-specific data frames which include the Ethernet address of the receiving station.

14. The method of one of the foregoing claims, characterized in that the terminal, when executing an instruction to open a file, reads the file allocation table; thus determines the sector and then reads the sector description table to determine the chapter to be looked for, executes the chapter, if the chapter resides in the RAM executed; sends a request for remote booting to the server, if the chapter is absent.

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15. The method of claim 14, characterized in that the sector description table includes a state byte indicating by one bit the reception of the chapter, by another bit its use, by a third bit the status "KEEP FOREVER", by a fourth bit the number of the segment, by a fifth bit the presence of a fill value, and by a sixth bit a data-specific sector.

16. The method of one of the foregoing claims, characterized in that the terminal includes a state register for the emulated interruption function, which in the case of the reception of an end of remote boot frame makes it possible to determine, by reading registers DL and AL of the microprocessor (213) of the terminal, whether it is necessary to perform a "load data segment" function or a "shutdown" function.

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ABSTRACT:

REMOTE BOOTING OF AN OPERATING SYSTEM BY A NETWORK

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The invention relates to a method for remote booting by a server of at least one terminal, including a volatile memory (RAM), at least one processor, a telecommunications card enabling connection to the server by a network, said server being provided with telecommunication means and memorization means of sufficient capacity to store the communications protocol, the operating system of the terminals recopied into an image file, its own operating system, and the applications programs, characterized in that it includes a method of remote loading of a startup program, consisting of transforming the first interruption produced by a terminal following its being powered up into a request for reading an image file memorized in the server.

Figure to be published with the abstract: Fig. 1

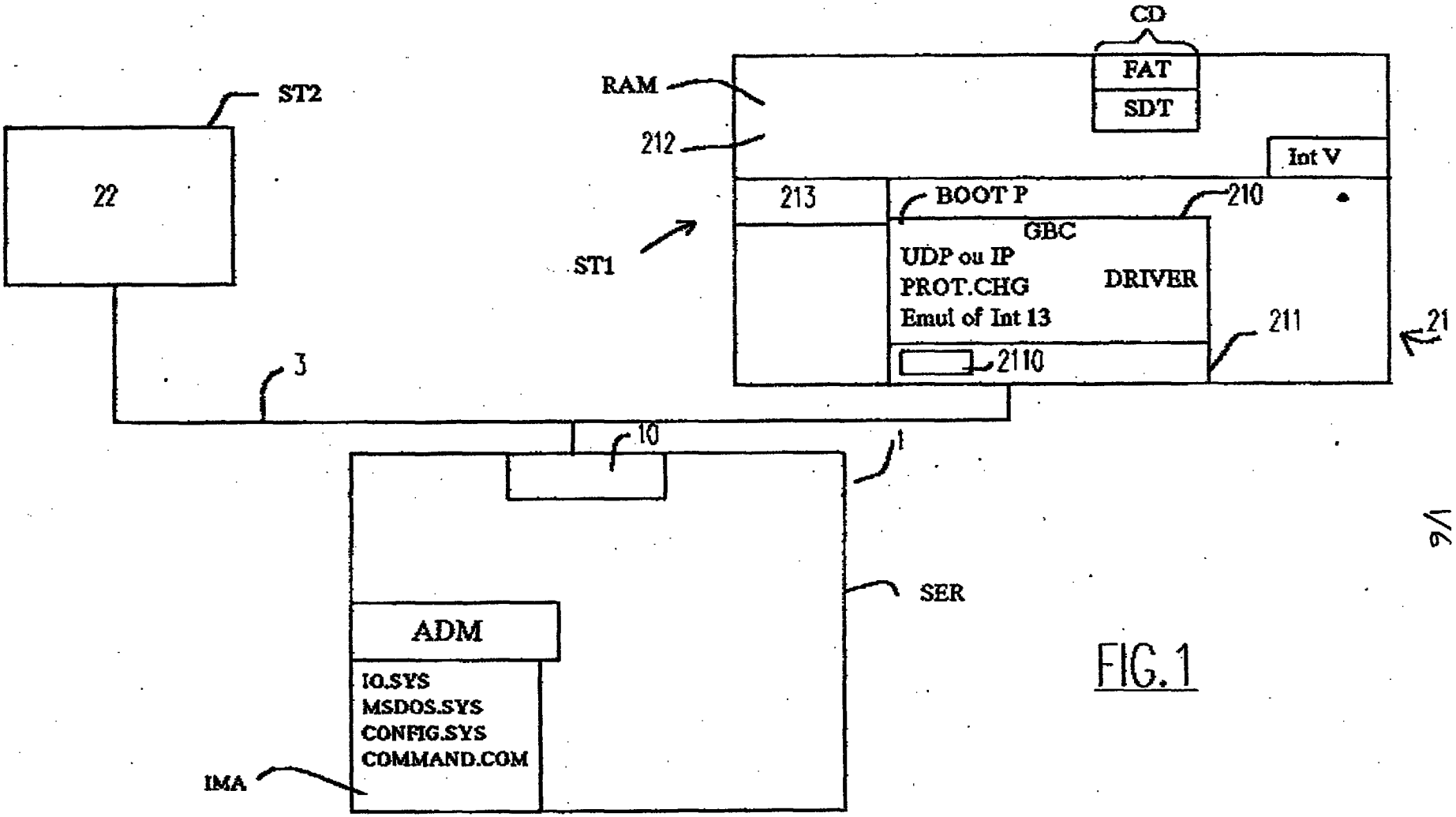

CD
FAT
SDT
RAM
ST2
212
Int V
22
213
BOOT P
210
GBC
UDP ou IP
PROT.CHG
DRIVER
Emul of Int 13
ST1
211
21
2110
3
10
1
SER
ADM
IO.SYS
MSDOS.SYS
CONFIG.SYS
COMMAND.COM
IMA

FIG.1

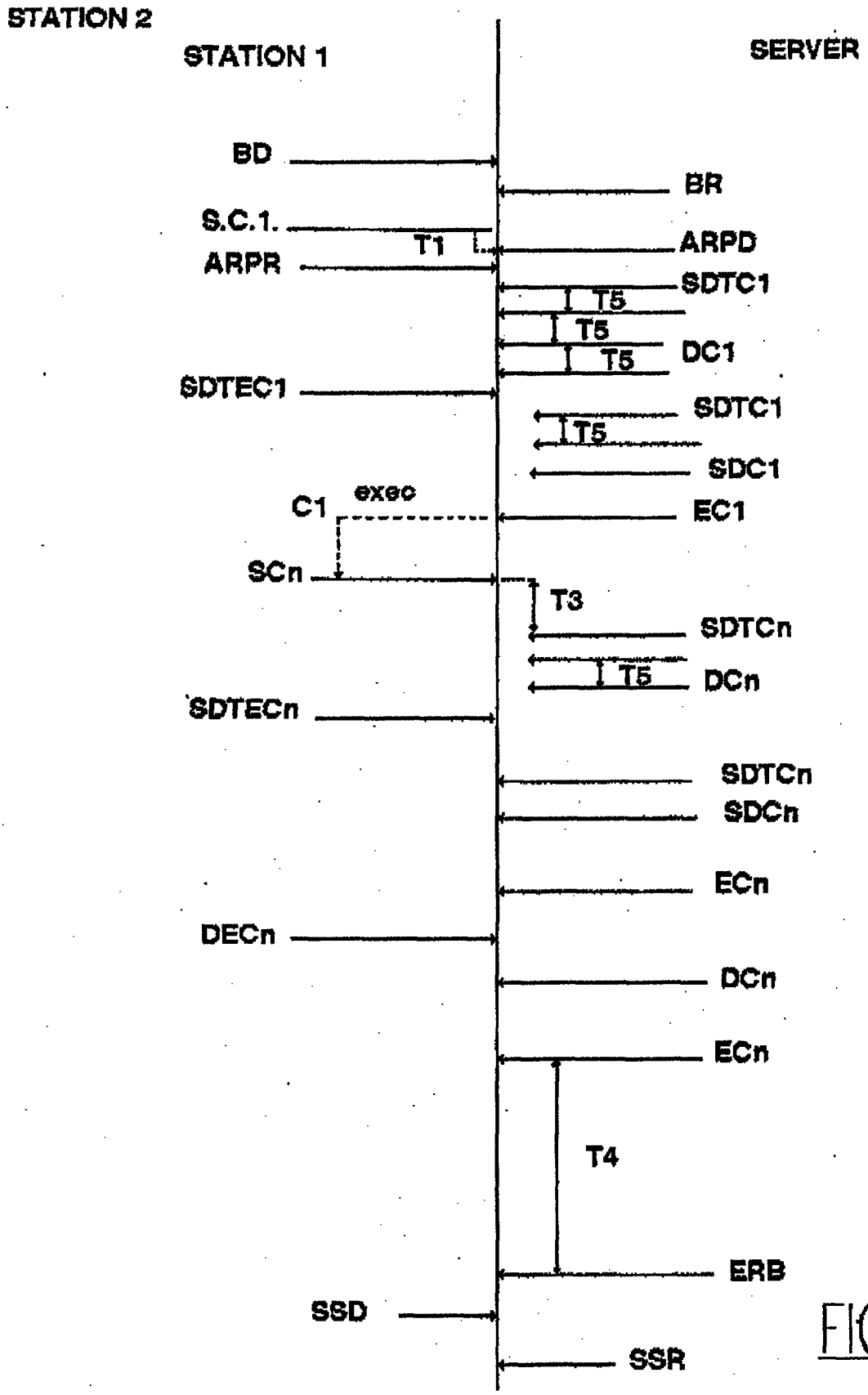

STATION 2
STATION 1
SERVER
BD
BR
S.C.1.
T1
ARPD
ARPR
SDTC1
T5
T5
DC1
T5
SDTEC1
SDTC1
T5
SDC1
C1
exec
EC1
SCn
T3
SDTCn
T5
DCn
SDTECn
SDTCn
SDCn
ECn
DECn
DCn
ECn
T4
ERB
SSD
SSR

FIG.2

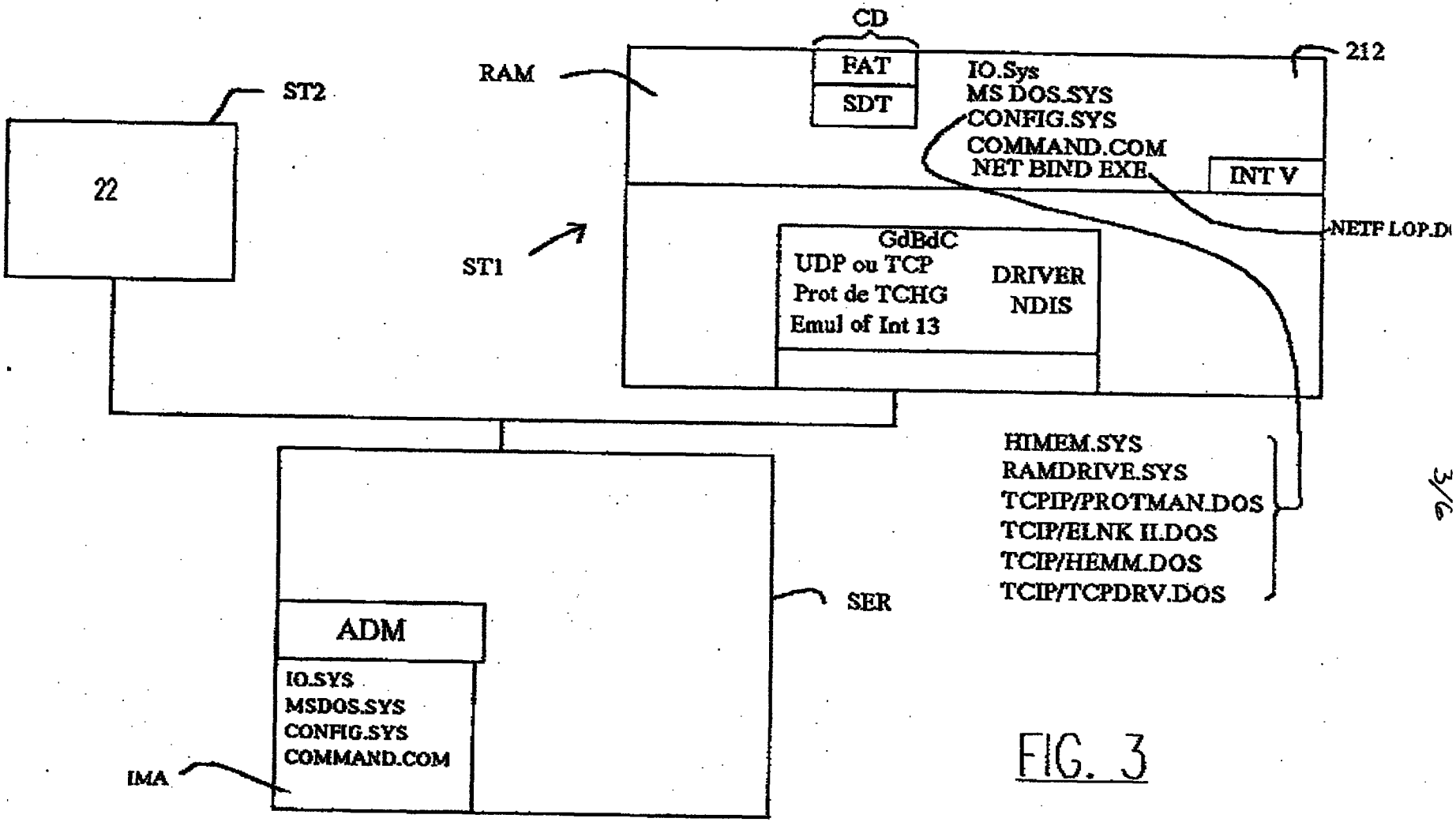

CD
FAT
SDT
RAM
212
IO.Sys
MS DOS.SYS
CONFIG.SYS
COMMAND.COM
NET BIND EXE
INT V
NETF LOP.D
ST2
22
ST1
GdBdC
UDP ou TCP
Prot de TCHG
Emul of Int 13
DRIVER
NDIS
HIMEM.SYS
RAMDRIVE.SYS
TCPIP/PROTMAN.DOS
TCIP/ELNK II.DOS
TCIP/HEMM.DOS
TCIP/TCPDRV.DOS
SER
ADM
IO.SYS
MSDOS.SYS
CONFIG.SYS
COMMAND.COM
IMA

FIG. 3

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SC - start chapter

type of frame	2 bytes	000h
Volume Name	12 bytes	
identifier	2 bytes	Chapter number in ASCII (01 for the first one)
IP Station	2 words	

SDT Chapter

type of frame	2 bytes	100h
Volume name	12 "	
identifier	2 "	Chapter number in ASCII
SDT Chapter frame mask	1 "	1 bit set per frame
SDT Chapter max frame mask	1 "	all the settable bits set
First data segment	2 "	
Second data segment	2 "	0 if none
Offset in SDT the following cards are to be put in	2 "	
Number of following cards	2 "	
cards	8 "	each SDC

SDC Sector Description Card

Sector number	2 bytes	
Sector alias	2 "	(0 if none)
Offset	2 "	offset in floppy cache (segment indicated by segment number bit)
Filling value	1 byte	
Status	8 bits	

7 6 5 4 3 2 1 0	
X----------	received
----X------	used
--------X--	Keep forever
----------X	Segment number
--------X---	Filling value
----------X	specifique Data sector (used by server program, not transmitted)

FIG. 4A

SDT Error

Type of frame	2 bytes	200h
Volume name	12 bytes	
identifier	2 bytes	
IP Station	2 words	
SDT chapter	1 byte	
frame mask		

SDC - Specific data chapter

type of frame	2 bytes	401h
Volume name	12 bytes	
identifier	2 bytes	Chapter number in ASCII
offset of 1st SDT card	2 bytes	
offset of 2nd SDT card	2 bytes	(O if none)
Ethernet address	6 bytes	
data	512 ou 1024 bytes	

DE - Data Error

type of frame	2 bytes	800h
Volume name	12 bytes	
identifier	2 bytes	Chapter number in ASCII
number of sectors missing	2 bytes	
Sectors numbers	2 bytes	for each sector

EC - End Chapter

type of frame	2 bytes	1000h
Volume name	12 bytes	
identifier	2 bytes	Chapter number in ASCII

FIG. 4B

ERB - End Remote Boot

type of frame	2 bytes	2000h
Volume name	12 bytes	
identifier	2 bytes	Chapter number in ASCII

SSD Spécifique Sector Request

type of frame	2 bytes	4000h
Volume name	12 bytes	
identifier	2 bytes	Chapter number in ASCII
Sector number	2 bytes	

SSR - Spécifique Sector Reply

type of frame	2 bytes	4001h
Volume name	12 bytes	
identifier	2 bytes	Chapter number in ASCII
Sector number	2 bytes	
data	512 bytes	

FIG.4C

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CLAIMS

1. A method for remote booting by a server of at least one terminal including a volatile memory (RAM), at least one processor, a telecommunications card enabling connection to the server by a network, said server being provided with telecommunication means and memorization means of sufficient capacity to store the communications protocol, the operating system of the terminals recopied into an image file, its own operating system and the applications programs, characterized in that it includes a method of remote loading of a startup program, consisting of transforming the first interruption of reading the boot sector of the local disk produced by a terminal following its being powered up, into a request for reading an image file memorized on the server, the program interruptions transformation being memorized in a non volatile memory (PROM) of the telecommunication card.

2. The method of claim 1, characterized in that the step of remote booting of the startup program consists of loading the startup (BOOT) sector into the volatile memory RAM, starting the execution of this startup file, transforming the interruptions requesting access to files of nonexistent magnetic peripherals of the terminal into requests for reading the corresponding image file in the server, by a procedure of coordinate transformation.

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3. The method of claim 2, characterized in that the procedure of coordinate transformation consists of transforming the coordinates of physical sectors of the files of the magnetic peripherals into a logical chapter numbering of the image file corresponding to the sector of the file called by a sector correspondence table, transmitting to the server the chapter reading request, and sending the chapters of the images files to the set of terminals.

4. The method of one of claims 1-3, characterized in that the volatile memory RAM of the terminal, after the first remote booting of the startup program, contains a file allocation table (FAT) establishing a correspondence among the diskette number, the head number, the track number, the track sector number, and the file name, and a sector description table (SDT) establishing a correspondence among the diskette number, the track number, the track sector number, and the chapter number of the image file of the server.

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* C L M S *

5. The method of one of the foregoing claim, characterized in that it enables the remote loading of files of the operating system, constituted by the IO.SYS, MSDOS.SYS, CONFIG.SYS and COMMAND.COM files.

6. The method of claim 4, characterized in that the file allocation table (FAT) is memorized with eternal status (KEEP FOREVER) in the random access memory RAM, this status indicating by one bit of the word the state of the sector description card.

7. The method of one of the foregoing claims, characterized in that when a terminal sends a request for a first chapter to the server, the server waits for a period of time T1 before replying, to assure that other terminals will not be having the same request.

8. The method of one of the foregoing claims, characterized in that a request for a first chapter by another station arriving before a period of time T2 following the request for the same first chapter by a first station has elapsed is accepted immediately, and the procedure of remote booting of all the stations having sent the requests is reset to 0 for these stations.

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* C L M S *

9. The method of one of the foregoing claims, characterized in that the server waits for a period of time T3 between the sending of each chapter and a time T5 between each frame transmission.

10. The method of one of the foregoing claims, characterized in that the server closes the session at the end of a time T4 after the sending of an end of chapter frame, if no other station has sent a request.

11. The method of one of claims 7 - 9, characterized in that the times T1-T5 are parametrizable.

12. The method of one of claims 1-7, characterized in that it includes a step of sending chapter-specific data frames which include the Ethernet address of the receiving station.

13. The method of claim 4, characterized in that the terminal, when executing an instruction to open a file, reads the file allocation table; thus determines the sector and then reads the sector description table to determine the chapter to be looked for, executes the chapter, if the chapter resides in the RAM executed; sends a request for remote booting to the server, if the chapter is absent.

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* C L M S *

14. The method of claim 14, characterized in that the sector description table includes a state byte indicating by one bit the reception of the chapter, by another bit its use, by a third bit the status "KEEP FOREVER", by a fourth bit the number of the segment, by a fifth bit the presence of a fill value, and by a sixth bit a data-specific sector.

15. The method of one of the foregoing claims, characterized in that the terminal includes a state register for the emulated interruption function, which in the case of the reception of an end of remote boot frame makes it possible to determine, by reading registers DL and AL of the microprocessor (213) of the terminal, whether it is necessary to perform a "load data segment" function or a "shutdown" function.

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