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(54) Title: INTERNET-BASED PROGRAM BROADCAST SYSTEM

(57) Abstract: A decentralized network for the high-quality transmission or live or prerecorded interactive Internet-based programs such as shows, classes, and meetings to a virtually unlimited number of clients (16) any place in the world. At least one bi-directional repeater/aggregator (12) communicates between a server (10) and one or more clients (12) for (1) receiving the program content from the server (10) over the communication pipe and re-broadcasting the content to a plurality of clients (12), and (2) aggregating data from the plurality of clients (12) and sending a composite thereof to the server (10) over the communication pipe.
patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
INTERNET-BASED PROGRAM BROADCAST SYSTEM

This application derives from and claims the benefit of U.S. Provisional Application No. 60/149,111, filed August 14, 1999, which is incorporated herein by reference in its entirety, and is also a continuation-in-part of U.S. Application No. (Attorney Docket No. R7600.0002/P002), filed July 6, 2000, entitled “Decentralized Internet-Based Program Production System,” which is incorporated herein by reference in its entirety.

BACKGROUND

It will be assumed that the reader is familiar with basic Internet technology. To the extent that explanatory information is required, the reader is referred to How The Internet Works by Preston Galla (1997, Ziff-Davis Press) and Computer Networks and Internets by Douglas Comer (Second Edition, 1999; Prentice-Hall, Inc.), the contents of which are hereby incorporated by reference.

The production of Internet-based program content and producer information can be thought of as consisting of two types of signals: (1) the audio and video content of the program itself (hereinafter, the “A/V content”) and (2) commands. The A/V content is typically sent to the client over the Internet as streaming video and streaming audio. Because audio and video content contain a large amount of information, streaming techniques typically compress the content, and transmit the compressed content to the client in IP packets using UDP protocol. Unlike the TCP protocol
typically used to transmit text, UDP does not constantly check to see if data has been received by the client, and does not resend packets if they are lost in the course of transmission to the client. The loss of video information (e.g., an occasional frame) or audio information is acceptable and is frequently minimally detectable by the viewer.

Producer information such as commands tell the system to launch such features as poll, chat, and talk-back and are known, per se, in Internet-based broadcast system technology. Poll, for example, typically launches one or more text-based questions, with a choice of answers for each question, and is a way to gather information about viewers' tastes, opinions, knowledge, etc. Chat provides the viewer with a way to interact with other viewers. Talk-back permits the viewer to send questions and comments directly to the commentator. Other features are known as well, and this list is only intended to be exemplary.

Similarly, the foregoing descriptions of streaming audio and video signals are exemplary only, and are not intended to limit the scope of the invention in any way.

Those skilled in the art appreciate that many different protocols can be used, although the foregoing are the currently used standards, and will understand that this invention is not limited to the use of any particular protocol, A/V content or command.

As the program content is created as part of the interactive presentation, the content's producer (or production team) launches commands, such as poll, with the intent that the viewer see and respond to the poll questions at particular points in the presentation. The broadcast is generated by a server to a number of clients. The A/V content and commands are received by the client and stored in respective buffers.
When the buffers fill, or reach some other predetermined condition, an audio player and a video player are launched within the viewer’s computer, and A/V content can be watched and heard while subsequent packets are being delivered. When viewers are to interact with the broadcast program, the viewers’ responses are sent to the broadcasting server.

In practice, the number of clients receiving and/or participating in an interactive broadcast is limited by many factors. Some of them are computer-specific resources (such as random access memory (RAM), central processing unit (CPU) speed, etc.), operating system-(OS) specific resources (e.g., WINDOWS NT has different limits than Unix), and bandwidth and network congestion which can substantially impede the quality and continuity of the server/client connection. Due to implementation specifics of sockets under most operating systems, the upper limit for the number of concurrent socket connections on a single machine is approximately 65,000 regardless of the other factors that may reduce that number substantially. The broadcast system must, however, be able to register and address the participants, broadcast to them, receive interactive input from them and respond appropriately to the interactive input within the limitations imposed.

The problems of bandwidth usage and network congestion are particularly troubling in the case of sustained Internet-based connections such as those experienced in live and taped broadcasts. Until quite recently, Internet-based communications have consisted mainly of downloaded Web pages requiring only momentary contacts between the server and client. Conventionally, the client contacts the desired server for
the Web page through the client’s Internet service provider (“ISP”). In providing the communication channel for the client, the ISP, in turn, is typically connected to a high speed, large bandwidth line called a “backbone”. Contact is made through the backbone, either directly or through other backbones and/or servers, with the server providing the desired Web page. Once the Web page is sent by the Web site’s server, it can disconnect from the network handling the request for the client, as can the client’s ISP once it receives the Web page.

Recently, private Internet-based networks have been formed to avoid delays associated with the public Internet sector. These private networks typically connect major ISP’s, for example, so that communications between clients of the respective ISPs do not experience the delays that are experienced when links must pass through the public portion of the Internet.

“Co-location facilities” have arisen that form these private networks by providing high-speed, large-bandwidth connections between the ISPs. In practice, the ISP pays a fee to the backbone provider or co-location facility (collectively referred to herein as “pipes”), which is generally proportional to the amount of traffic the ISP generates. Stated another way, the ISP pays a fee proportional to bandwidth occupied.

**SUMMARY**

In accordance with a preferred embodiment, a decentralized network is provided for the high-quality transmission of live or prerecorded interactive Internet-based programs such as shows, classes, and meetings to a virtually unlimited number of clients
any place in the world. The network can be implemented as, for example, a streaming
media broadcasting network with full interactivity capable of accessing a large world-
wide audience (e.g., one million users) with a broadcast server requiring only a single T1
line or the like.

In accordance with a preferred embodiment of the invention, at least one bi-
directional repeater/aggregator communicates between a server and one or more clients
for (1) receiving the program content from a server and rebroadcasting the content to a
plurality of clients, and (2) aggregating data from the plurality of clients and sending a
composite thereof to the server. Preferably, the server is programmed to fold the
composite input presented by each repeater/aggregator into a picture of the total
audience response.

The resulting increase in number of serviceable clients is arithmetic. If, for
example, each repeater/aggregator can service 10,000 clients, every added
repeater/aggregator can increase the potential audience by 10,000 within substantially
less bandwidth than that required by a direct connection to the same number of
viewers. Thus, with a decentralized network, a content producer with three
repeater/aggregators can reach 30,000 viewers; a content producer with seven
repeater/aggregators can reach 70,000 users, etc., all within the bandwidth typically
required to reach 10,000.

Preferably, the audio, video, and interactive content will travel the shortest
possible distance over the public Internet, ensuring a high-quality transmission. While
the placement of a server and one or more R/As at the upstream end of the program
producer's T1 line may solve the operating system and hardware limitations on the number of concurrent sockets, bandwidth would still be an issue. Preferably, the network disclosed herein accordingly decentralizes the bandwidth required by putting the R/A's as close to the viewer as possible from a network topology standpoint. For example, if a number of viewers on AOL are logged onto the program, the preferred location for the R/A serving them is the same network segment as the modem pool at AOL where those viewers dial into. The next (less preferred) location is on the AOL network. The next (even less preferred) location is on a well-connected network that is connected directly to AOL privately (i.e., not through a public Internet exchange, which are known to be congested).

In accordance with a preferred embodiment of the invention, one or more bidirectional repeaters/aggregators may be located at the client's ISP, a single transmission received at the ISP can be converted at the ISP's end to the multiple transmissions needed by the ISP's clients who are receiving the broadcast. If, for example, 1000 AOL subscribers are receiving the broadcast, the broadcasting server need not transmit 1000 streams to that group of clients, but only a single stream which is repeated 1000 times by the repeater/aggregator(s) within AOL's network, thus saving substantial bandwidth usage between the broadcast server and the ISP network.

Similarly, the return channel may be aggregated prior to transmission so that responses from the viewers can be sent as a single stream back to the broadcast server rather than a plurality of individual streams, with attendant bandwidth savings as well. Back channel responses can be aggregated for pre-determined lengths of time prior to
transmission, or until a desired quantity of data has been accumulated, or some
combination of the two. Alternatively, other criteria can be used which make back
channel transmission more efficient and/or cost effective.

5

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a block diagram schematic of an exemplary decentralized network for
transmitting interactive Internet-based programs constructed in accordance with an
exemplary embodiment of the invention.

FIG. 2 is a block diagram of an exemplary decentralized network suitable for
sustained live or taped Internet-based broadcasts, constructed in accordance with an
exemplary embodiment of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Preferred embodiments in application of the invention will now be described
with reference to FIG. 1. For illustration purposes only, this disclosure will describe the
production system in terms relevant to classroom and/or entertainment programming.
Unless the context indicates otherwise, the term “commentator” will be used to denote
the classroom instructor, the entertainment program’s host and/or other persons being
viewed at the moment by the viewer; “client” will denote the viewer’s computer system,
including hardware and software; “server” will denote the computer(s) (including
hardware and software) which deliver the program content to the client, and “viewer”
will refer to the person(s) at the client end of the system. Other embodiments may be
realized and structural or logical changes may be made to the disclosed embodiments without departing from the spirit or scope of the invention. Although the embodiments are particularly described as applied to production systems in terms relevant to classroom and/or entertainment programming, it should be readily apparent that the invention may be embodied in any device or system having the same or similar problems.

As illustrated in FIG. 1, an exemplary system constructed in accordance with an exemplary embodiment of the invention is composed of a production server in the form of audio/video server 10 for broadcasting content and information such as an audio/video stream and commands to clients 16, 18, 20, 22, 24, 26. A plurality of repeater/aggregators 12, 14 (each hereinafter, referred to as an “R/A” for brevity) are coupled for bi-directional communication with the server 10, and receive the broadcast program from the server. The R/As may be physically located anywhere in the world, but are preferably geographically positioned to provide the shortest transmission path to the clients they each serve.

The first R/A 12 is illustratively shown coupled for bi-directional communication with three clients 16, 18, 20 while the second R/A 14 is illustratively coupled for bi-directional communication with another three clients 22, 24, 26.

Although only two R/As have been illustrated for clarity, those skilled in the art will recognize that any number (e.g., thousands) of R/As can be used. Likewise, only three
clients have been illustrated for each R/A for clarity, but any number (e.g., thousands) of clients can be coupled to each R/A in actual use.

Each R/A 12, 14 repeats the interactive content transmitted by the server 10. Some or all of the content may conveniently be partially or wholly pre-loaded into the R/As prior to actual broadcast to the clients.

Each R/A 12, 14 additionally collects and aggregates feedback from the viewers with whom it is communicating so that a composite user input can be passed along to the producer’s register. If a multiple-choice exam question is launched from the server, for example, having three possible answers “A,” “B,” and “C,” each R/A aggregates the answers received from the clients with which it is communicating, and reports back to the register the number (or percentage of) clients returning “A,” returning “B,” and returning “C” answers.

By aggregating the data, information can be returned to the register utilizing less bandwidth than would be required by the return of individual responses from each client. Further, each R/A can be programmed to retain the answers from each specific client, or other non-priority data, for later transmission to the register at a time when bandwidth is available or the time more convenient. Moreover, any of a variety of reports can be generated from the raw data accumulated in the R/As. For example, statistical analyses can be performed, trends and correlations analyzed, etc. The reports can be generated at the R/As, or some or all the raw data can later be transmitted to the register or any other location for a global analysis. The data from the R/As to the
register or other receiving location, can accordingly be sent continuously or the data

can be batch-processed and forwarded in batches.

In exemplary operation, a viewer may log into the system via an R/A which, in
turn, registers the viewer with the server 10. The client may be registered using any

known identification system, such as by both the socket number at which the client’s

R/A is coupled to the server, as well as by the R/As socket number at which the client

is connected. The system is thereby flexible enough to enable the program’s A/V

content and/or producer information such as selected commands to be downloaded by

one or more specific clients at one or more specific R/As by tagging the

content/command packet with the appropriate addresses. Thus, producer information

can be sent to viewers in response to specific inputs, the presence of certain keywords in,

for example, a talk-back or chat statement, or in response to any other criteria which the

producer or broadcaster wishes to use. Producer commands thus enable a variety of

functions to be performed such as chat (between two or more clients), poll of users, etc.

Bandwidth is also saved by combining the interactive feedback from all clients at

each R/A prior to transmission to the server. Transmitting combined feedback saves

the protocol overhead which would otherwise arise from generating and processing

separately headered packets from directly connected clients.

Bandwidth can also be saved by using each R/A as a filter to avoid or delay

transmission of irrelevant (or non-priority) data to the server. For example, the

unnecessary transmission to the server, and processing by the server, of each and every

bid in an Internet-based auction is avoided when each R/A only transmits the highest
bid cast by the clients to which it is connected. Bids which are less than the highest are irrelevant. Accordingly, only the highest of the bids received from the clients within each predefined window are forwarded to the server.

Preferably, clients connect to the producer’s register, which assigns the client to the appropriate R/A, to which the client connects or is connected. Each client’s user logs on by providing his/her username and password. The register to which the user is connected confirms that the user is registered. If the user is not registered, a registration procedure can be launched.

Once registration is completed or confirmed, the user receives files which will be used as the program is viewed. These files may, for example, be plug-ins, players, slides, interface artwork, and software updates. Preferably, the files have previously been loaded into a plurality of distribution servers 28, 30 for transmission to the client through the R/As after log-in. In practice, it is desirable to have one or more ratios of R/As to each distribution server (e.g., one distribution server for every five R/As). The server is thereby free to perform other tasks, while many more clients can be serviced than by the server alone.

Clients may be assigned to a particular R/A based upon parameters deemed important to the particular broadcast. For example, it may be desirable to assign clients to R/As that are geographically closest to them. This may, however, result in an uneven assignment of clients among the available R/As, which load some R/As while utilizing others inefficiently. Alternatively, users may be assigned to R/As in a “round robin” manner, whereby users are evenly distributed among the R/As as they log in.
Additional servers can be employed if desirable. For example, archive servers are preferably employed to store archived broadcasts for future, on-demand access by participants. When receiving and evaluating audience response, it may also be desirable to assign specific tasks to individual servers. For example, a news programmer might want to pay special attention to the incoming Talk Back messages, and so would assign a separate server to handle only Talk Back. Meanwhile, another operator at another server could tend exclusively to Chat searches, a third operator at a third server could monitor Poll results, etc.

Incoming data can then be parsed and searched so that an operator can control the quantity, by controlling the quality, of audience feedback. The program director will accordingly only receive that input which will most benefit the show.

The network described herein may additionally include monitoring capabilities to maintain the high levels of performance for its producers. Various “status” systems monitor the network continuously, redirecting traffic as required by the network, requiring various “proxy” servers to act as intermediaries in checking producers’ and participants’ licenses and registration permissions, handling updates and directing traffic to the appropriate repeater/aggregators based on geographic location.

The system register permits the producer to register the show, and gather general and specific demographic information from an aggregated database. The register creates the aggregated database by tracking all the activity that occurs during presentation of the program, and organizing the data by producers and participants. All viewer data is preferably logged in appropriate tables from which reports can
subsequently be generated. Viewers connect to the Register to search for show and
schedule information.

The foregoing network may be implemented in accordance with a preferred
embodiment of the invention for sustained live or taped Internet-based broadcasts
which reduces bandwidth use within a pipe.

In the illustrated embodiment, a control provider such as broadcast server 110 is
connected to a pipe 112 to which a plurality of ISPs 114, 116, 118 have connections
available. The ISPs are shown having clients 114a-c, 116a-c and 118a-c, respectively,
who are part of the audience receiving the broadcast from server 110. In practice, there
will be many more than the illustrated three ISPs and three clients/ISP. One or more
repeaters/aggregators 120 are placed in the ISP network as previously described so that
the incoming broadcast stream is duplicated as many times as needed to serve the ISP’s
clients logged onto the broadcast. Since only a single stream travels through the pipe to
the ISP, bandwidth use is substantially reduced, as are use-related fees charged to the
ISP by the pipe’s owner. When the ISP’s clients respond interactively to the broadcast,
their messages are aggregated and sent as a single stream through the pipe or,
alternatively, reduced to the minimum number of packets and/or streams capable of
carrying the data, resulting in greater efficiencies and less bandwidth use once again.

In accordance with a preferred embodiment of the invention, one or more
processor-based systems are used to implement the modules described or apparent from
the description herein (e.g., server 10, distribution servers 28, 30, R/As 12, 14, and
clients 16, 18, 20, 22, 24, 26) and to perform the functionality described (or inherent)
herein. For each such system, one or more processors (e.g., central processing unit (CPU)) are provided for execution of one or more computer programs stored on any (one or more) known recording mediums. The processor(s) perform, control, or at least inform the various processing steps performed by the system in sending and retrieving data to and from at least one user interface and/or network. A user interface may be connected directly to a bus or remotely connected through a network (e.g., Internet). The network represents (wired or wireless) connection of two or more devices, whether directly or indirectly connected (e.g., directly coupling through cable, indirect coupling through one or more hubs or servers, whether the network is local to the processor-based system, geographically remote from system, or a distributed combination of local/remote network components).

Preferably, one or more of the modules depicted in FIG. 1 and/or FIG. 2 are coupled (directly or indirectly) to one or more database structures for use in supplying storage functionality for the modules in accordance with the operations described (or inherent) herein (e.g., storage of pre-loaded content in R/As, operating as the system or producer’s register, etc.). The database structures can take any form from an individual floppy disk drive, hard disk drive, CD-ROM, redundant array of independent devices (RAID) system, to a network of storage devices. As is well known in the art, the database structures may be physically connected within the same location, or have one or more structures remotely located in different locations. Each module may have dedicated or shared access to one or more database structures locally or remotely located from the module.
The preferred embodiments described herein relate to Internet-based program production systems capable of producing live interactive classroom instruction, virtual "meeting halls," live interactive entertainment-type shows, pre-recorded interactive programs, and the like. It should be apparent, however, that many modifications (e.g., structural, logical, etc.) to the embodiments and implementations of the invention can be made without departing from the spirit or scope of the invention. The type of program content, for example, is unlimited and it is foreseeable that the content can be at least the same as an interactive version of anything currently found on television or in the cinema. Moreover, any known network or communication system (e.g., intranet, extranet, local area network (LAN), wide area network (WAN), BBS, instant messaging network, etc.) may be used in lieu of or in combination with the Internet, as used herein.

While the exemplary embodiments disclosed herein depict a broadcast system utilizing a computer-based client application, it should be readily apparent that the invention may be implemented utilizing any type of equivalent client apparatus (e.g., network/stand-alone computers, personal digital assistants (PDAs), WebTV (or other Internet-only) terminals, set-top boxes, cellular/PCS phones, screenphones, pagers, kiosks, thin-client, or other known (wired or wireless) communication devices) executing one or more computer programs (e.g., specialized client software, standard Web browser software, etc.) to permit communication with a host service. Alternative embodiments further include both centralized and decentralized distribution of programs or content.
The components described herein may be one or more hardware, software, or hybrid components residing in (or distributed among) one or more local or remote computer systems. Although the components are shown or described as physically separated components, it should be readily apparent that individual components may be omitted, combined, or further separated into a variety of different components, sharing different resources (including processing units, memory, clock devices, software routines, etc.) as required for the particular implementation of the embodiments disclosed herein. Indeed, even a single general purpose computer executing a computer program stored on a recording medium to produce the functionality referred to herein may be utilized to implement one or more of the components in the illustrated embodiments. Any user interface devices utilized may be implemented as a graphical user interface (GUI) containing a display or the like, or may be a link to other user input/output devices known in the art.

In addition, memory units described herein may be any one or more of the known storage devices (e.g., Random Access Memory (RAM), Read Only Memory (ROM), hard disk drive (HDD), floppy drive, zip drive, compact disk-ROM, DVD, bubble memory, etc.), and may also be one or more memory devices embedded within a processor or CPU, or shared with one or more of the other components. The computer programs or algorithms described (or inherent) herein may easily be configured as one or more hardware components, and the hardware components shown may easily be configured as one or more software components without departing from
the invention. Accordingly, the invention is not limited by the description or drawing of this disclosure, but only by the claims appended hereto.

What is claimed is:
1. A broadcast system for broadcasting content and broadcaster information to users during a program, the system comprising:

   a broadcaster generating content and related broadcaster information;

   at least one repeater/aggregator, wherein each repeater/aggregator receives the content and the broadcaster information from said broadcaster through a communication pipe and broadcasts the content and broadcaster information to at least one user; and

   wherein each repeater/aggregator receives feedback information from the at least one user, aggregates the feedback information, and outputs the aggregated feedback information to the broadcaster through the communication pipe.

2. The system of claim 1 further comprising a server, said server producing and outputting over the communication pipe the content and broadcaster information generated by said broadcaster to said at least one repeater/aggregator, and receiving the aggregated feedback information from said at least one repeater/aggregator during the program.

3. The system of claim 1 further comprising at least one interactive client component associated with at least one user, each client component receiving the content and broadcaster information from an associated repeater/aggregator and presenting the content and broadcaster information to the user, each client component receiving feedback information from the user and transmitting it to its associated repeater/aggregator.
4. The system of claim 3, wherein the broadcaster information includes at least one command to be executed on said at least one client component.

5. The system of claim 4, wherein the command comprises a chat function to be performed between at least two client components associated with at least two users.

6. The system of claim 4, wherein the command comprises a poll function to be performed by at least one client component associated with at least one user.

7. The system of claim 4, wherein the command comprises a talk-back function to be performed by at least one client component associated with at least one user.

8. The system of claim 1, wherein each repeater/aggregator filters the feedback information prior to sending the aggregated feedback information to said broadcaster.

9. The system of claim 1, wherein said at least one repeater/aggregator is a plurality of repeater/aggregators coupled to the pipe, wherein each repeater/aggregator is connected to the users via the Internet through an Internet Service provider (ISP).

10. The system of claim 1, wherein the communication pipe is a private network.

11. A production system comprising:

   a production server, said production server producing and outputting a program and inputting information from viewers during the production of the program;
a plurality of interactive clients each respectively associated with at least one viewer, each client receiving the program and presenting it to a viewer, each client receiving information from a viewer; and

at least one repeater/aggregator, each repeater/aggregator connected to said production server by a communication pipe, each repeater/aggregator being further connected to and associated with at least one client, each repeater/aggregator receiving the program from the pipe and distributing it to its associated client, each repeater/aggregator inputting information from its associated client, processing the information and distributing it to said production server using the pipe.

12. The system of claim 11, wherein the program comprises audio and visual information.

13. The system of claim 11, wherein the user information comprises feedback information concerning the program.

14. The system of claim 11, wherein said production server further outputs to each repeater/aggregator producer information to be executed by at least one client.

15. The system of claim 14, wherein the producer information comprises commands to be performed by at least one client associated with at least one viewer.

16. The system of claim 11 further comprising at least one distribution server associated with and connected to at least one repeater/aggregator, each distribution server being further connected to said production server, each distribution server
transmitting files associated with said program to its respective repeater/aggregator for use by the viewers during the program.

17. The system of claim 16, wherein the files are selected from the group consisting of plug-ins, players, slides, artwork and software updates.

18. The system of claim 11, wherein the communication pipe is an Internet backbone.

19. A method of producing a program to be broadcast over a network to a plurality of users, the method comprising the steps of:

providing the program to a plurality of repeater/aggregators over a private communication pipe;

distributing the program from each repeater/aggregator to the plurality of users over the public Internet;

receiving feedback information over the communication pipe from at least one of the plurality of users through an associated one of the plurality of repeater/aggregators;

aggregating the feedback information; and

incorporating the aggregated feedback into the program.

20. The method of claim 19, further comprising the step of screening content of the feedback information prior to said aggregating step.
wherein at least one of the plurality of repeater/aggregators is located at each of
a plurality of Internet Service Providers (ISPs) connecting the users to the public
Internet, and wherein the plurality of ISPs are coupled to the communication pipe.
### INTERNATIONAL SEARCH REPORT

**International application No.**

PCT/US00/22110

### A. CLASSIFICATION OF SUBJECT MATTER

**IPC(7)** : H04N 7/14  
**US CL** : 348/1, 13; 455/2  
According to International Patent Classification (IPC) or to both national classification and IPC

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

- U.S. : 348/1, 13; 455/2

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of data base and, where practicable, search terms used)

- WEST 2.0, CAS ONLINE, DIALOG, IEEE

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tr>
<td>A</td>
<td>US 5,257,099 A (MORALES-GARZA) 26 October 1993, see entire document.</td>
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☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special category of cited documents

**A** document defining the general state of the art which is not considered to be of particular relevance  

**E** earlier document published on or after the international filing date  

**L** document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)  

**O** document referring to an oral disclosure, use, exhibition or other means  

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