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(54) METHOD OF DOING BUSINESS OVER A NETWORK BY TRANSMISSION AND RETRANSMISSION OF DIGITAL INFORMATION ON A NETWORK DURING TIME SLOTS

(75) Inventors: **Norbert George Vogl**, Mahopac, NY (US); **Geoffrey Hale Purdy**, Roxbury, CT (US); **Robert Alan Flavin**, Yorktown Heights, NY (US); **Yuan Feng**, White Plains, NY (US); **Edward Payson Clarke, JR.**, Ossining, NY (US)

Correspondence Address:
HARRINGTON & SMITH, PC
4 RESEARCH DRIVE, Suite 202
SHELTON, CT 06484-6212 (US)

(73) Assignee: **International Business Machines Corporation**

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Publication Classification

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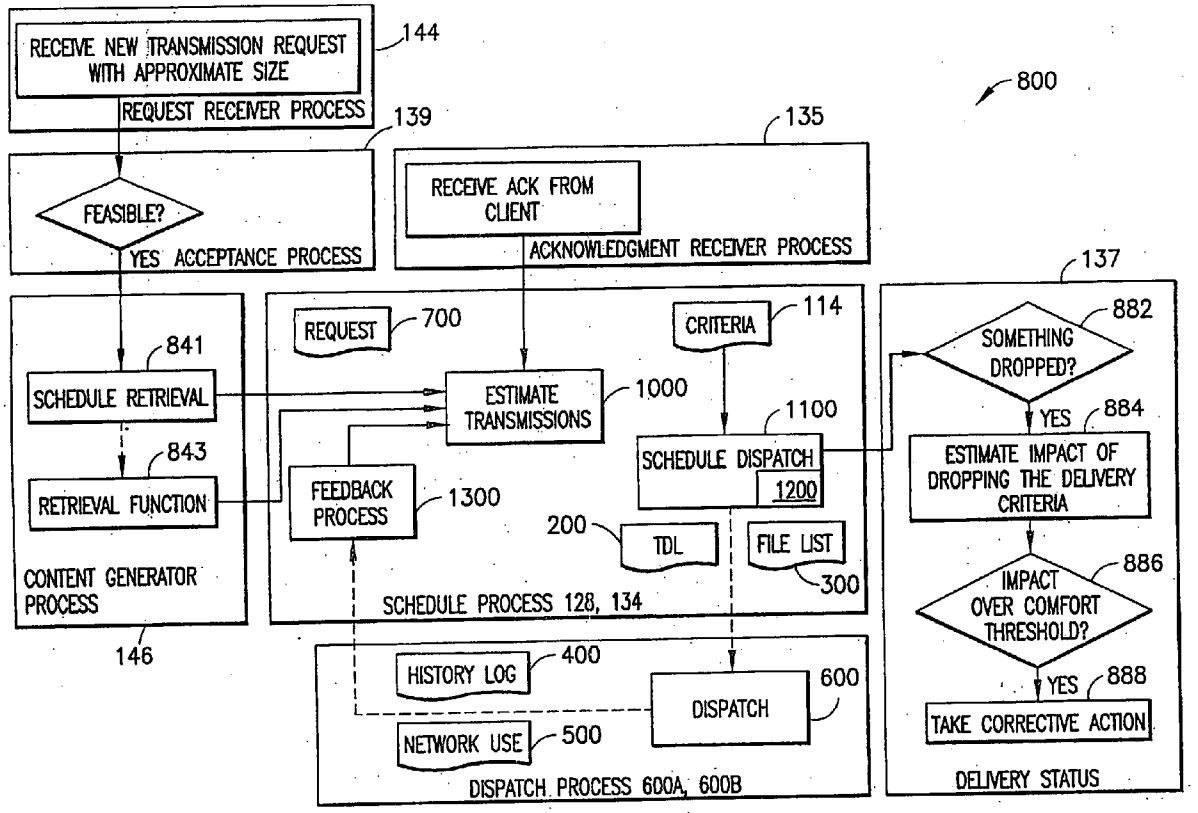
(52) **U.S. Cl.** **705/26**

(57) **ABSTRACT**

The present invention is a method of doing business over a network that: receives a request for transmitting digital information after a start time and before an end time, determines the time required to transmit the digital information based on the number of packets in the information and the network speed, schedules a transmit time for the digital information, and accepts the digital information for transmission only if the time required to transmit is less than or equal to the difference between the transmit time and the end time. Pricing of the transmission can be determined by the priority of transmission, whether the information is transmitted the first time or rescheduled, and whether the user receives an acknowledgment.



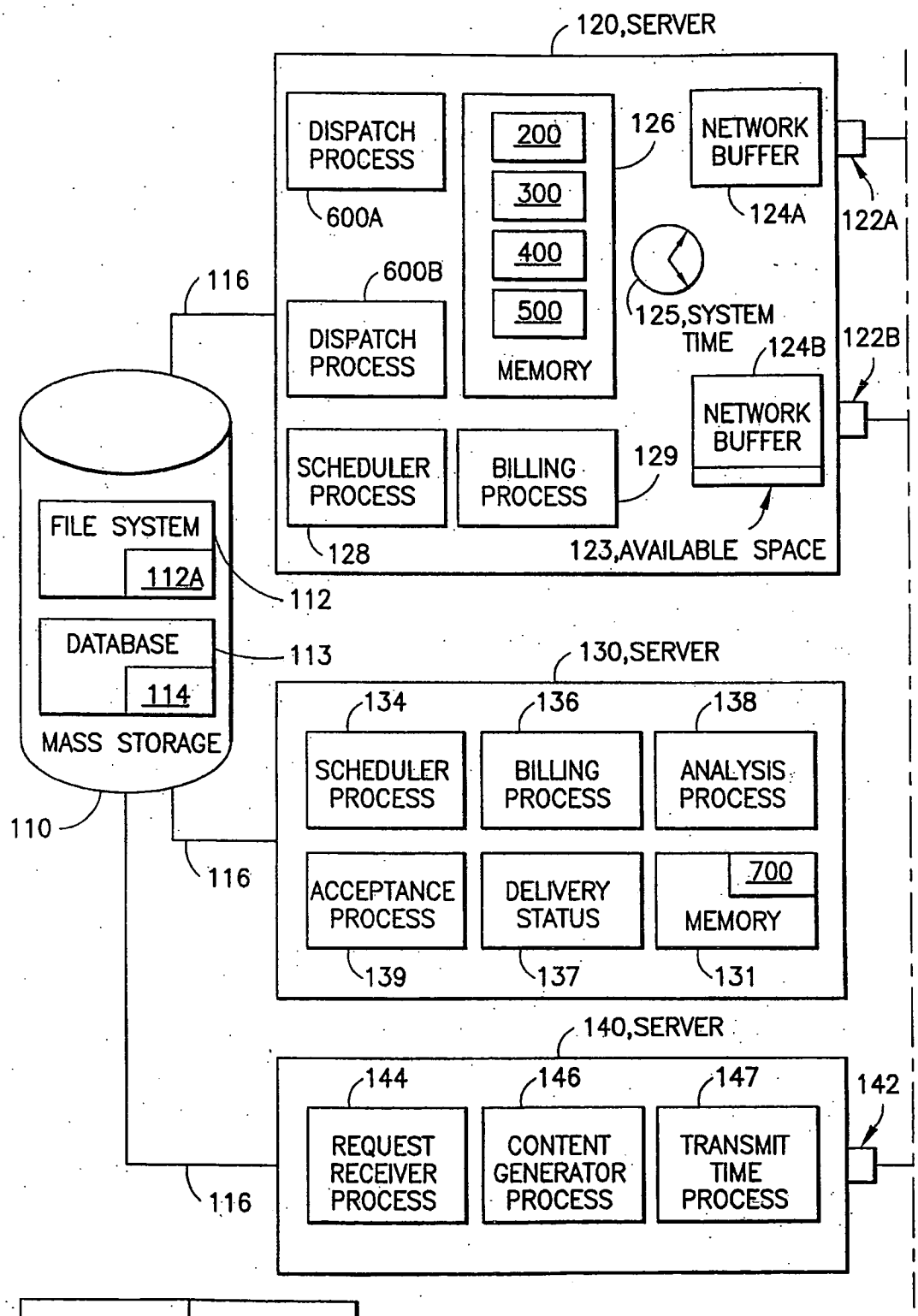


FIG.1A | FIG.1B

FIG.1

FIG.1A

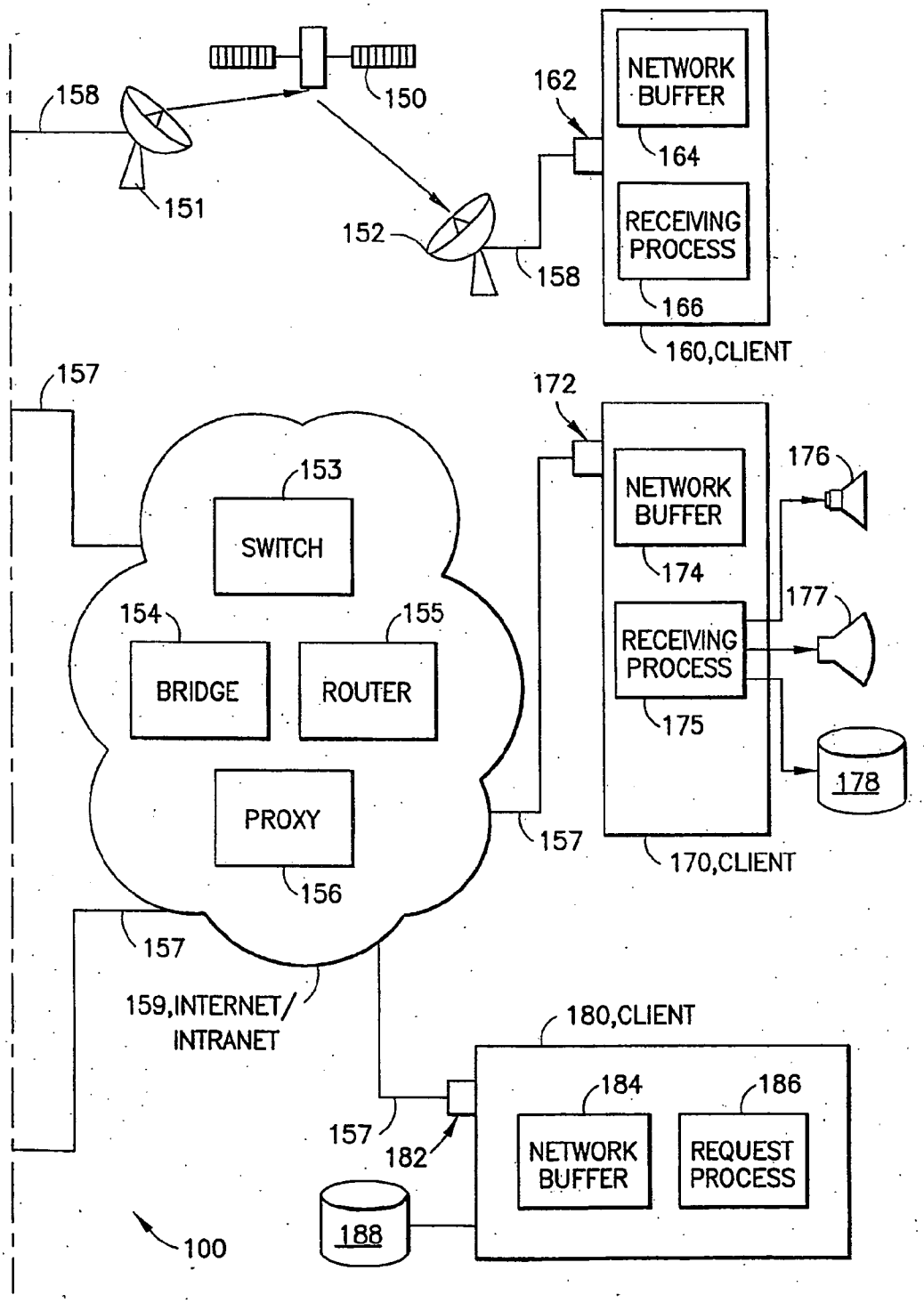

158
150
151
152
158
162
NETWORK BUFFER
164
RECEIVING PROCESS
166
160,CLIENT
157
172
NETWORK BUFFER
174
RECEIVING PROCESS
175
176
177
178
170,CLIENT
153
SWITCH
154
BRIDGE
155
ROUTER
PROXY
156
157
157
159,INTERNET/ INTRANET
180,CLIENT
184
NETWORK BUFFER
186
REQUEST PROCESS
157
182
188
100

FIG. 1B

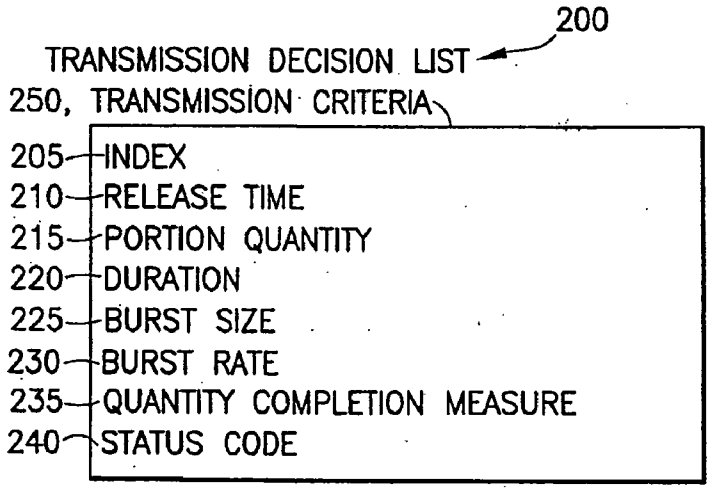


FIG.2

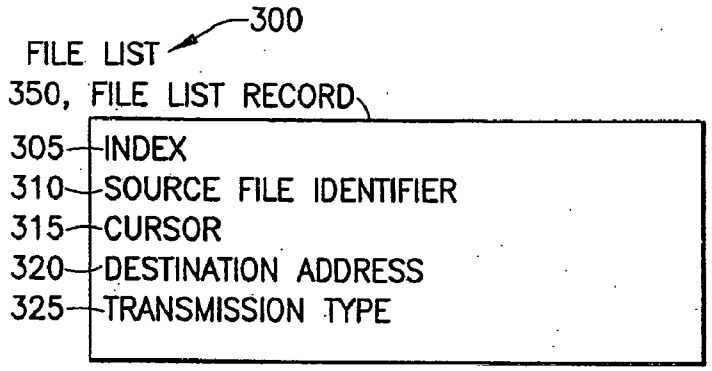


FIG.3

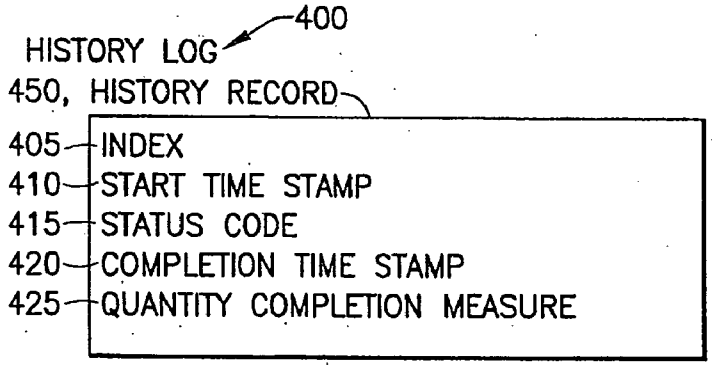


FIG.4

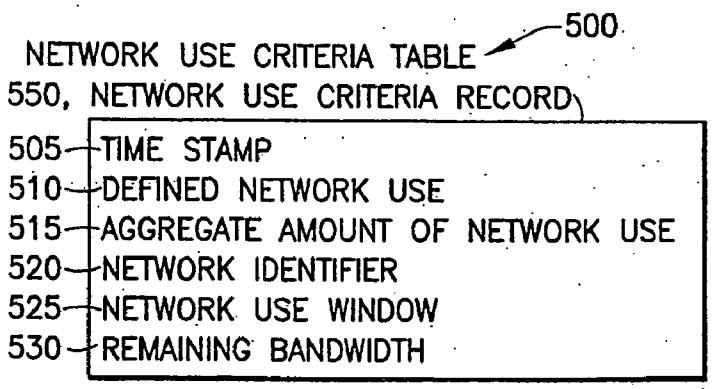


FIG.5

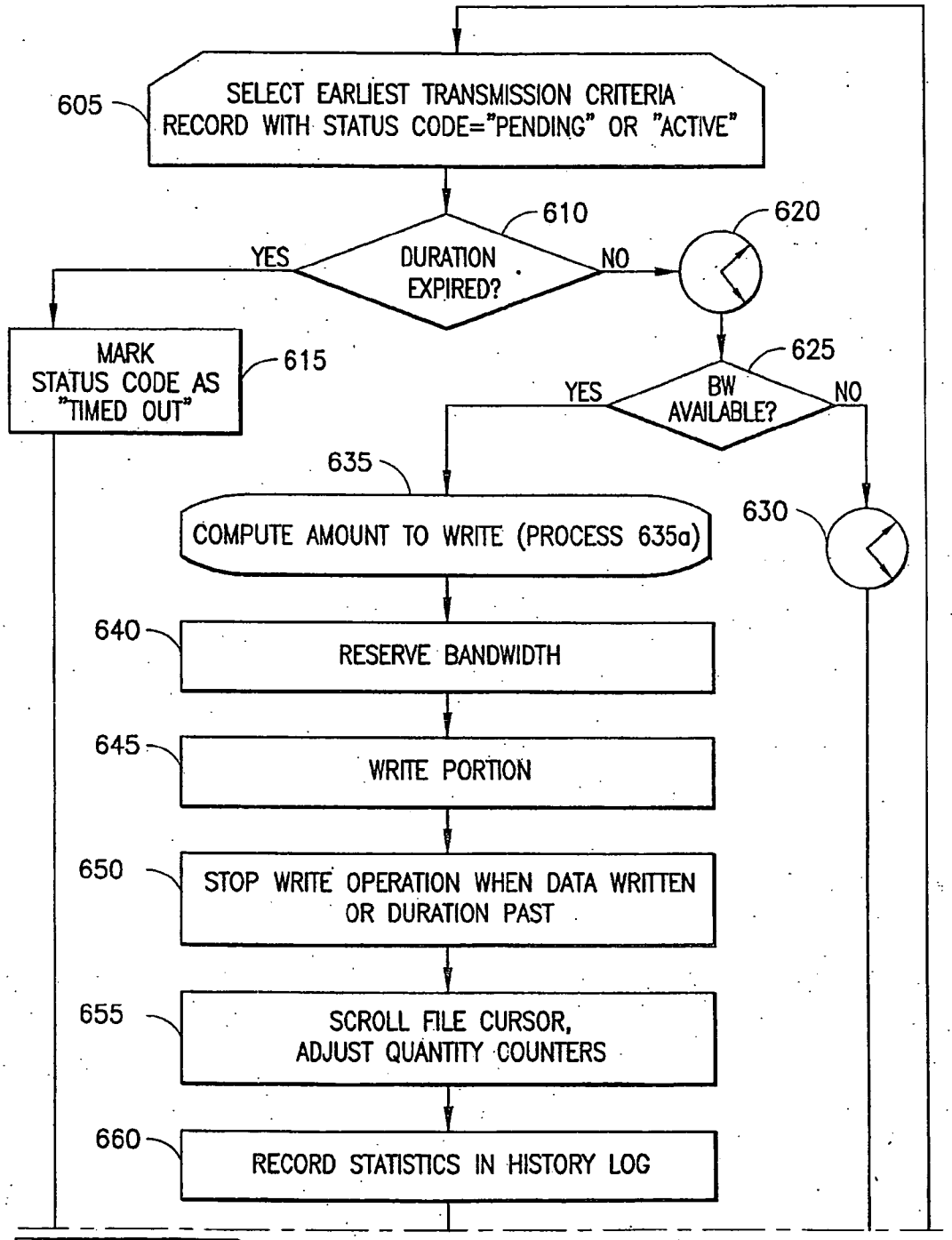


FIG.6-1

FIG.6-1
FIG.6-2

FIG.6

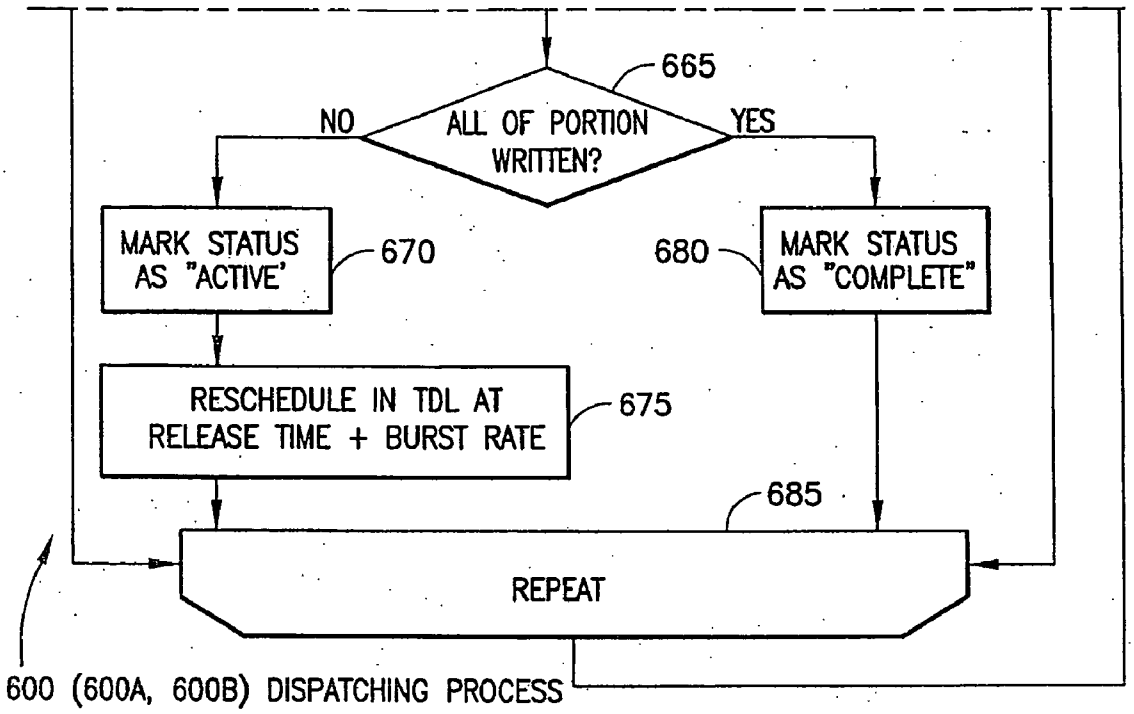

665
ALL OF PORTION WRITTEN?
NO
YES
MARK STATUS AS "ACTIVE'
670
680
MARK STATUS AS "COMPLETE"
RESCHEDULE IN TDL AT RELEASE TIME + BURST RATE
675
685
REPEAT
600 (600A, 600B) DISPATCHING PROCESS

FIG.6–2

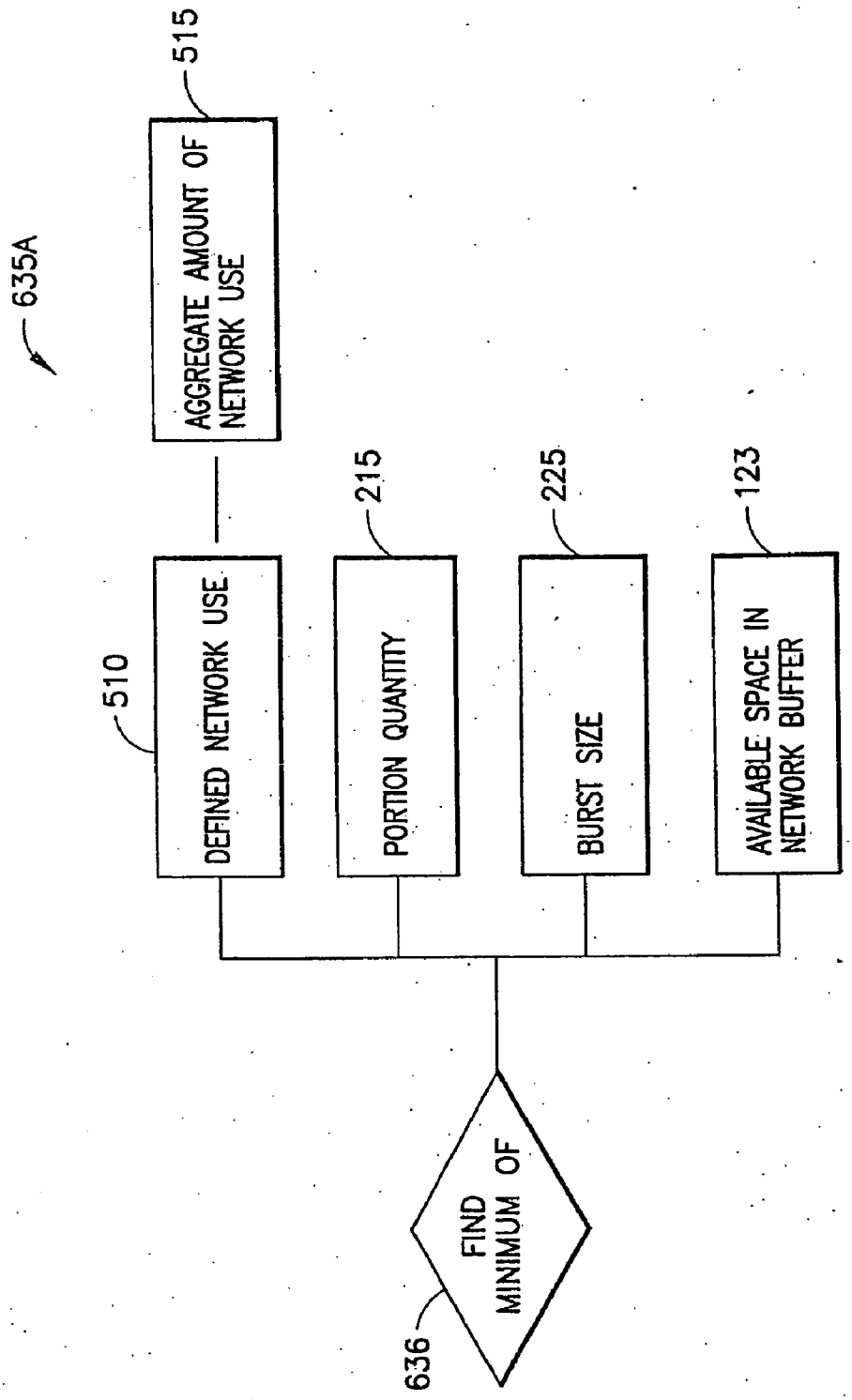

635A
515
AGGREGATE AMOUNT OF NETWORK USE
510
DEFINED NETWORK USE
215
PORTION QUANTITY
225
BURST SIZE
123
AVAILABLE SPACE IN NETWORK BUFFER
636
FIND MINIMUM OF

FIG.6A

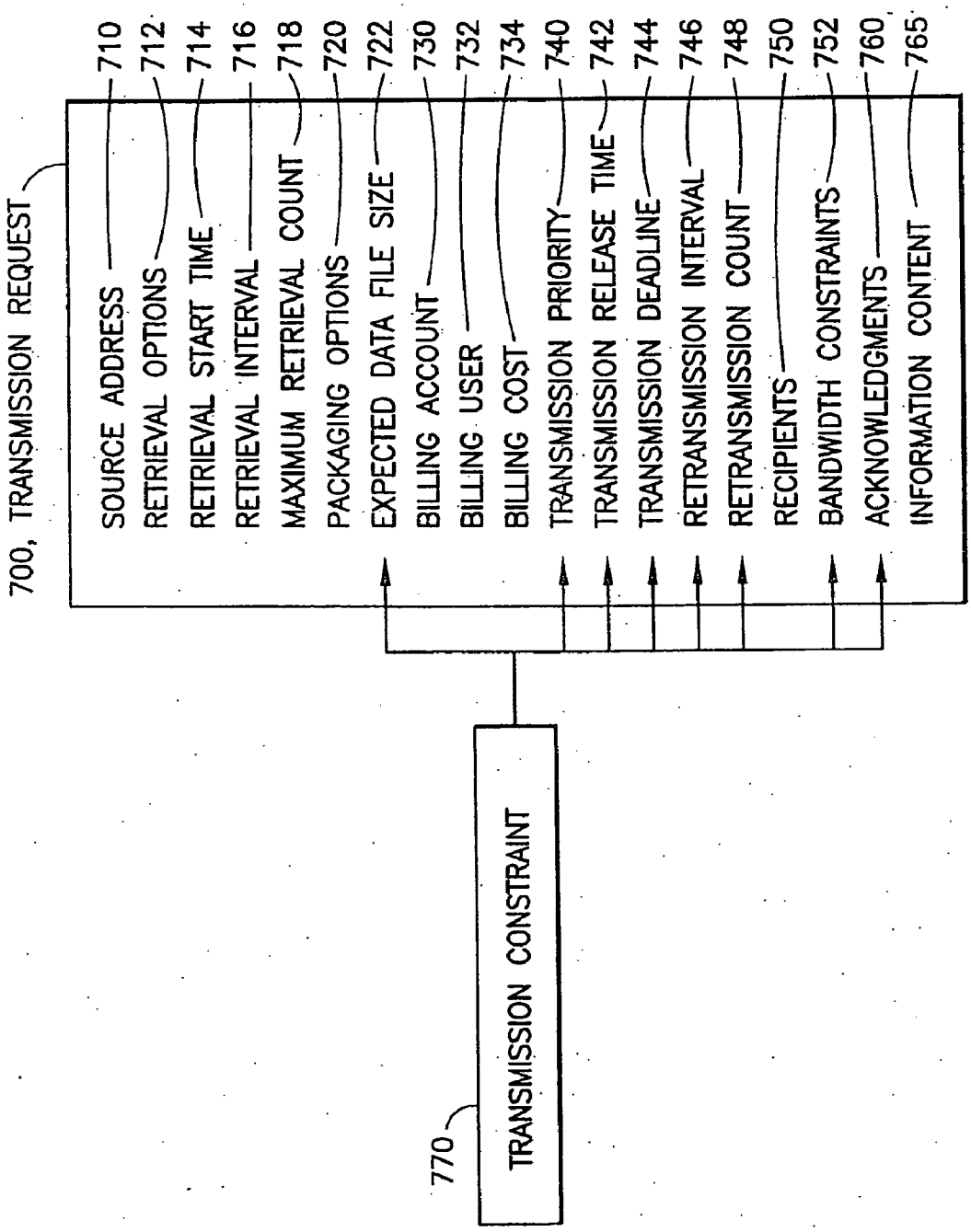

700, TRANSMISSION REQUEST
SOURCE ADDRESS 710
RETRIEVAL OPTIONS 712
RETRIEVAL START TIME 714
RETRIEVAL INTERVAL 716
MAXIMUM RETRIEVAL COUNT 718
PACKAGING OPTIONS 720
EXPECTED DATA FILE SIZE 722
BILLING ACCOUNT 730
BILLING USER 732
BILLING COST 734
TRANSMISSION PRIORITY 740
TRANSMISSION RELEASE TIME 742
TRANSMISSION DEADLINE 744
RETRANSMISSION INTERVAL 746
RETRANSMISSION COUNT 748
RECIPIENTS 750
BANDWIDTH CONSTRAINTS 752
ACKNOWLEDGMENTS 760
INFORMATION CONTENT 765
770
TRANSMISSION CONSTRAINT

FIG. 7

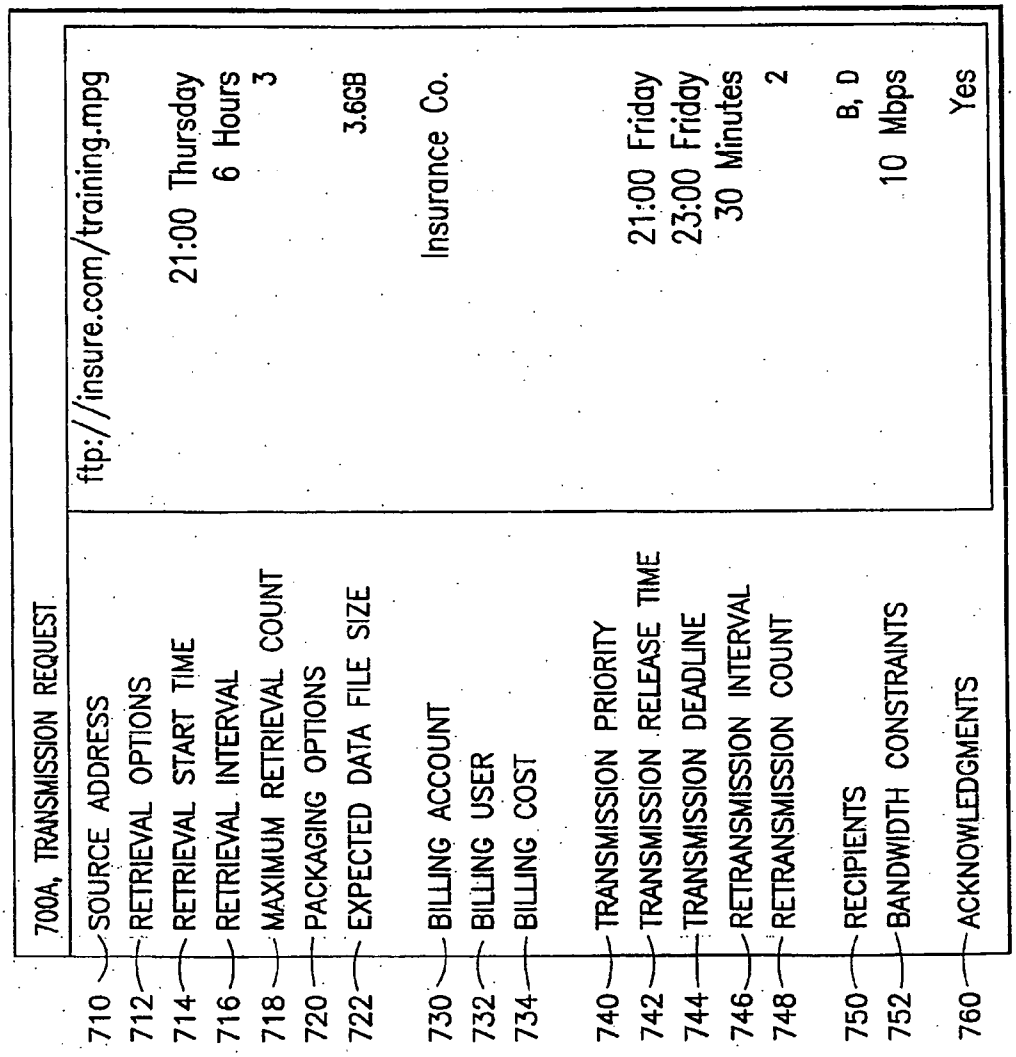

700A, TRANSMISSION REQUEST
710 SOURCE ADDRESS
ftp://insure.com/training.mpg
712 RETRIEVAL OPTIONS
714 RETRIEVAL START TIME
21:00 Thursday
716 RETRIEVAL INTERVAL
6 Hours
718 MAXIMUM RETRIEVAL COUNT
3
720 PACKAGING OPTIONS
722 EXPECTED DATA FILE SIZE
3.6GB
730 BILLING ACCOUNT
Insurance Co.
732 BILLING USER
734 BILLING COST
740 TRANSMISSION PRIORITY
742 TRANSMISSION RELEASE TIME
21:00 Friday
744 TRANSMISSION DEADLINE
23:00 Friday
746 RETRANSMISSION INTERVAL
30 Minutes
748 RETRANSMISSION COUNT
2
750 RECIPIENTS
B, D
752 BANDWIDTH CONSTRAINTS
10 Mbps
760 ACKNOWLEDGMENTS
Yes

FIG. 7A

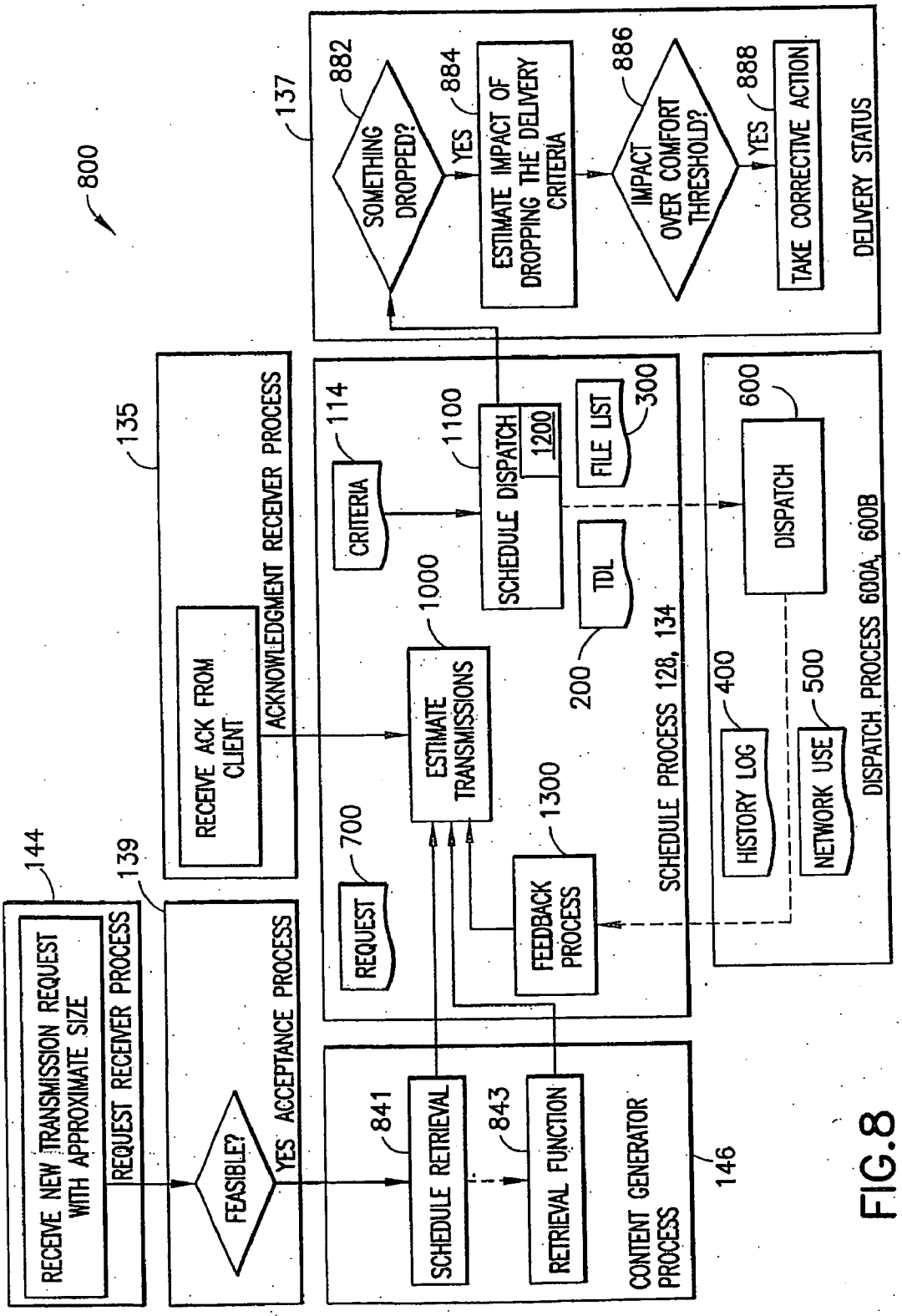

800
137
882
SOMETHING DROPPED?
YES
884
ESTIMATE IMPACT OF DROPPING THE DELIVERY CRITERIA
886
IMPACT OVER COMFORT THRESHOLD?
YES
888
TAKE CORRECTIVE ACTION
DELIVERY STATUS
135
RECEIVE ACK FROM CLIENT
ACKNOWLEDGMENT RECEIVER PROCESS
114
CRITERIA
1100
SCHEDULE DISPATCH
1200
FILE LIST
300
600
DISPATCH
1000
ESTIMATE TRANSMISSIONS
TDL
200
SCHEDULE PROCESS 128, 134
400
HISTORY LOG
500
NETWORK USE
DISPATCH PROCESS 600A, 600B
144
RECEIVE NEW TRANSMISSION REQUEST WITH APPROXIMATE SIZE
REQUEST RECEIVER PROCESS
139
FEASIBLE?
YES
ACCEPTANCE PROCESS
700
REQUEST
1300
FEEDBACK PROCESS
841
SCHEDULE RETRIEVAL
843
RETRIEVAL FUNCTION
CONTENT GENERATOR PROCESS
146

FIG.8

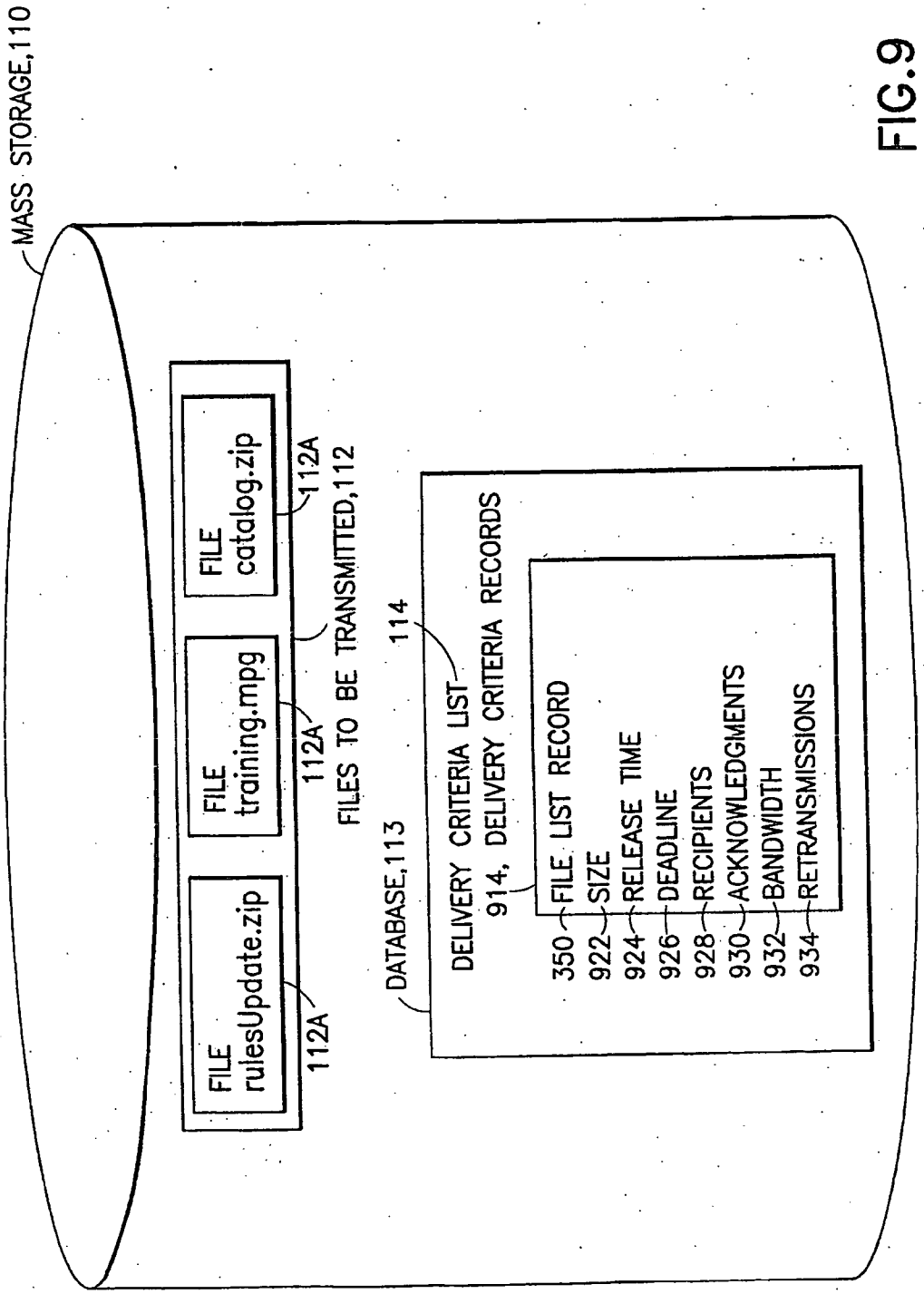

MASS STORAGE,110
FILE rulesUpdate.zip
FILE training.mpg
FILE catalog.zip
112A
112A
112A
FILES TO BE TRANSMITTED,112
DATABASE,113
114
DELIVERY CRITERIA LIST
914, DELIVERY CRITERIA RECORDS
FILE LIST RECORD
350
SIZE
922
RELEASE TIME
924
DEADLINE
926
RECIPIENTS
928
ACKNOWLEDGMENTS
930
BANDWIDTH
932
RETRANSMISSIONS
934

FIG.9

DELIVERY CRITERIA LIST, 114

350(310) FILE IDENTIFIER	922 SIZE	924 RELEASE TIME	926 DEADLINE	928 RECIPIENTS	930 ACK	932 BANDWIDTH	934 RETRANS
914A training.mpg	3.6GB	21:00 FRI.	23:00 FRI.	B, D	YES	10 Mbps	2
914B training.mpg	3.6GB	21:30 FRI.	23:00 FRI.	B, D	YES	10 Mbps	1
914C training.mpg	3.6GB	22:00 FRI.	23:00 FRI.	B, D	YES	10 Mbps	0
914D rulesUpdate.zip	375MB	21:30 FRI.	22:00 FRI.	A, B	NO	5 Mbps	0
914E catalog.zip	750MB	22:00 FRI.	22:30 FRI.	C	NO	10 Mbps	0

FIG.9A

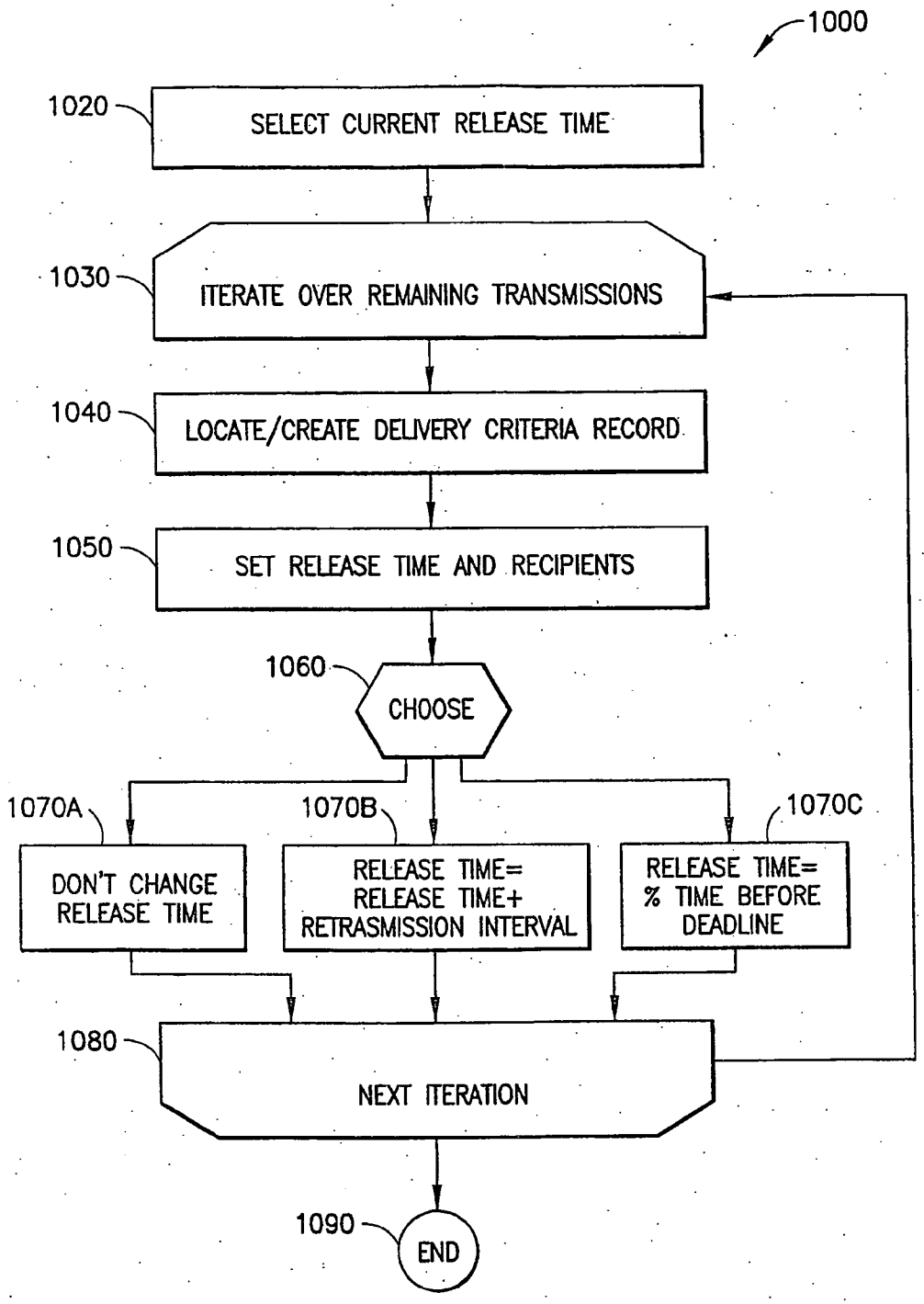

1000
1020
SELECT CURRENT RELEASE TIME
1030
ITERATE OVER REMAINING TRANSMISSIONS
1040
LOCATE/CREATE DELIVERY CRITERIA RECORD
1050
SET RELEASE TIME AND RECIPIENTS
1060
CHOOSE
1070A
DON'T CHANGE RELEASE TIME
1070B
RELEASE TIME= RELEASE TIME+ RETRASMISSION INTERVAL
1070C
RELEASE TIME= % TIME BEFORE DEADLINE
1080
NEXT ITERATION
1090
END

FIG.10

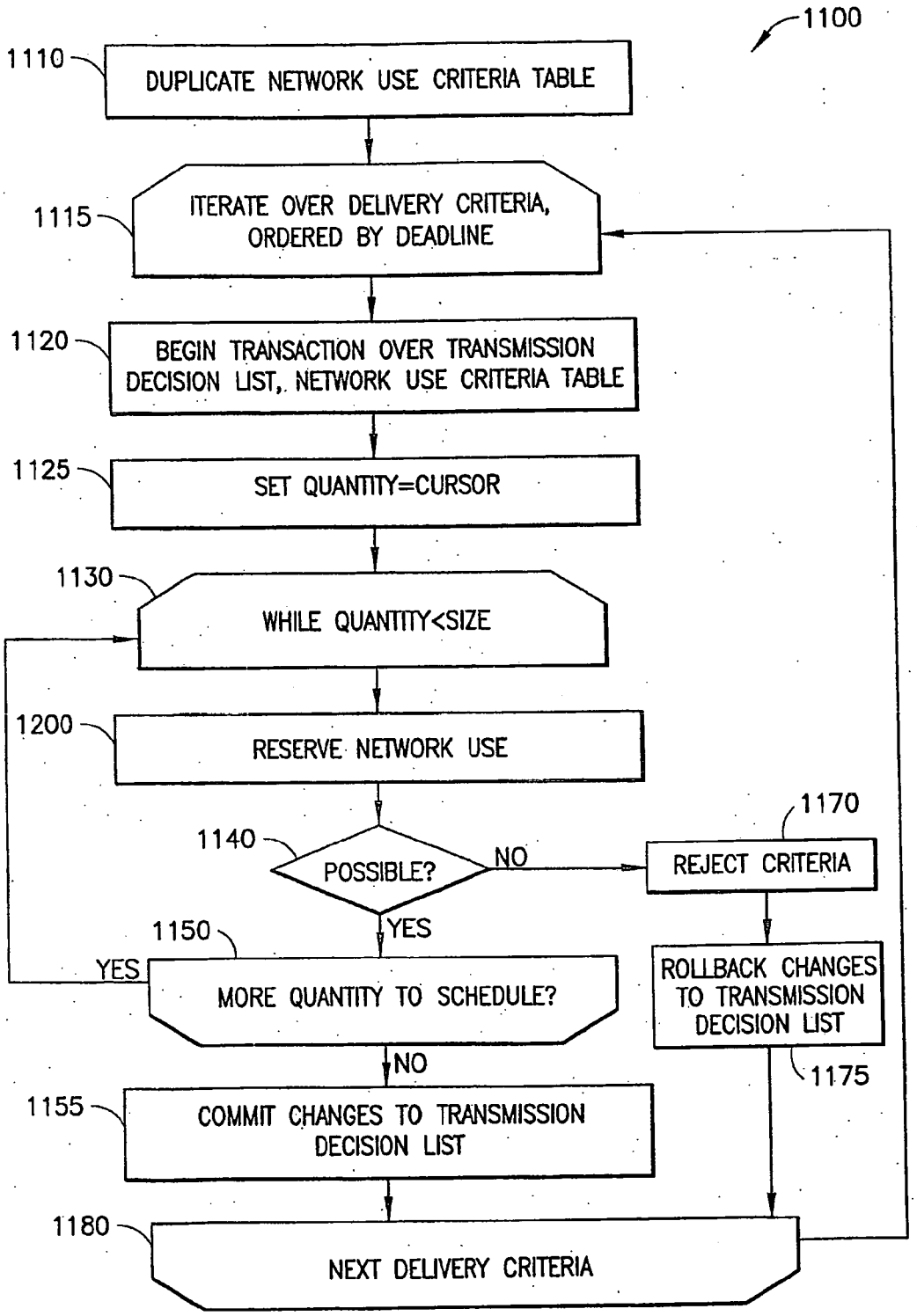

1100
1110
DUPLICATE NETWORK USE CRITERIA TABLE
1115
ITERATE OVER DELIVERY CRITERIA, ORDERED BY DEADLINE
1120
BEGIN TRANSACTION OVER TRANSMISSION DECISION LIST, NETWORK USE CRITERIA TABLE
1125
SET QUANTITY=CURSOR
1130
WHILE QUANTITY<SIZE
1200
RESERVE NETWORK USE
1140
POSSIBLE?
NO
1170
REJECT CRITERIA
YES
1150
YES
MORE QUANTITY TO SCHEDULE?
ROLLBACK CHANGES TO TRANSMISSION DECISION LIST
1175
NO
1155
COMMIT CHANGES TO TRANSMISSION DECISION LIST
1180
NEXT DELIVERY CRITERIA

FIG.11

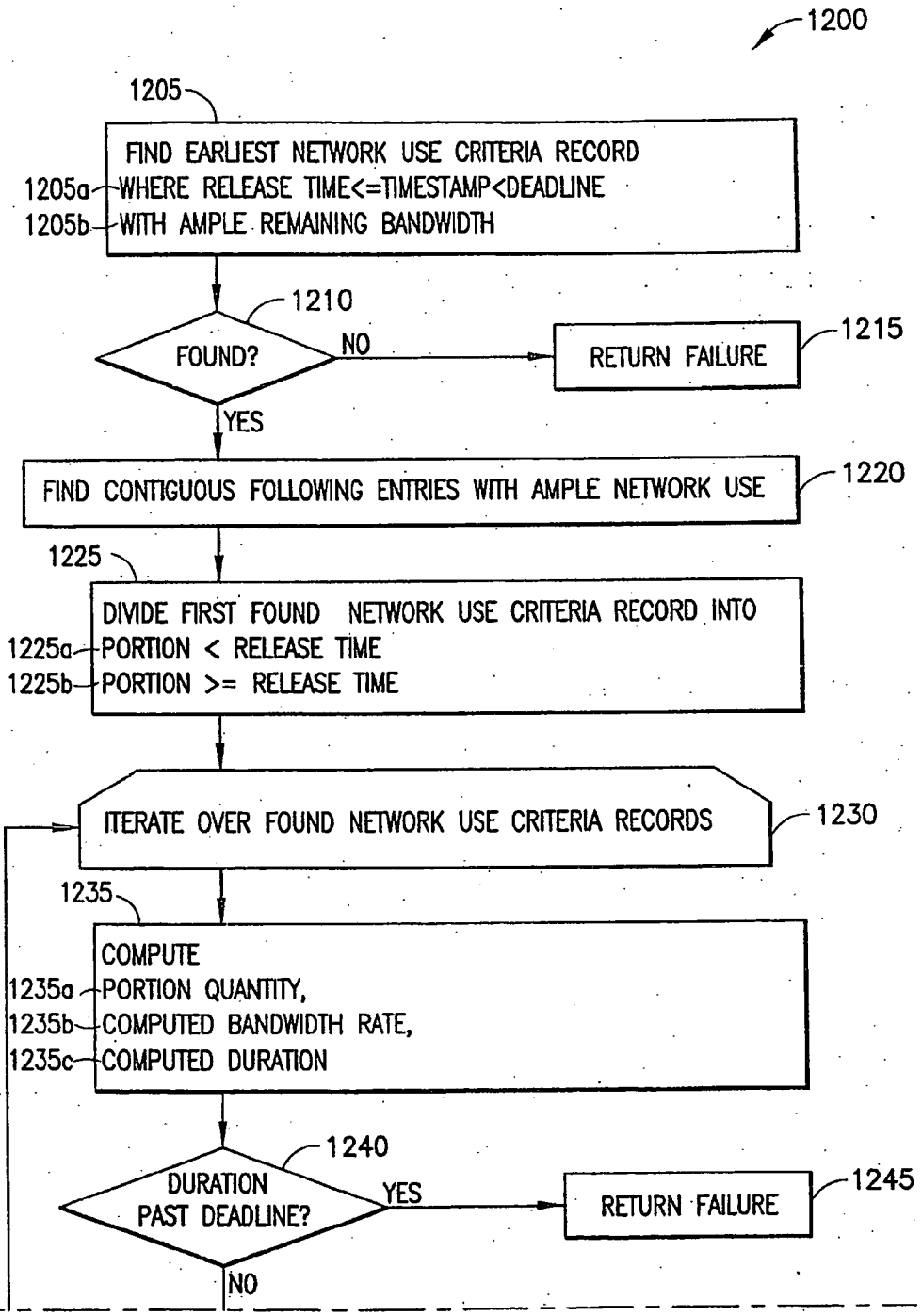


FIG.12A

FIG.12A
FIG.12B

FIG.12

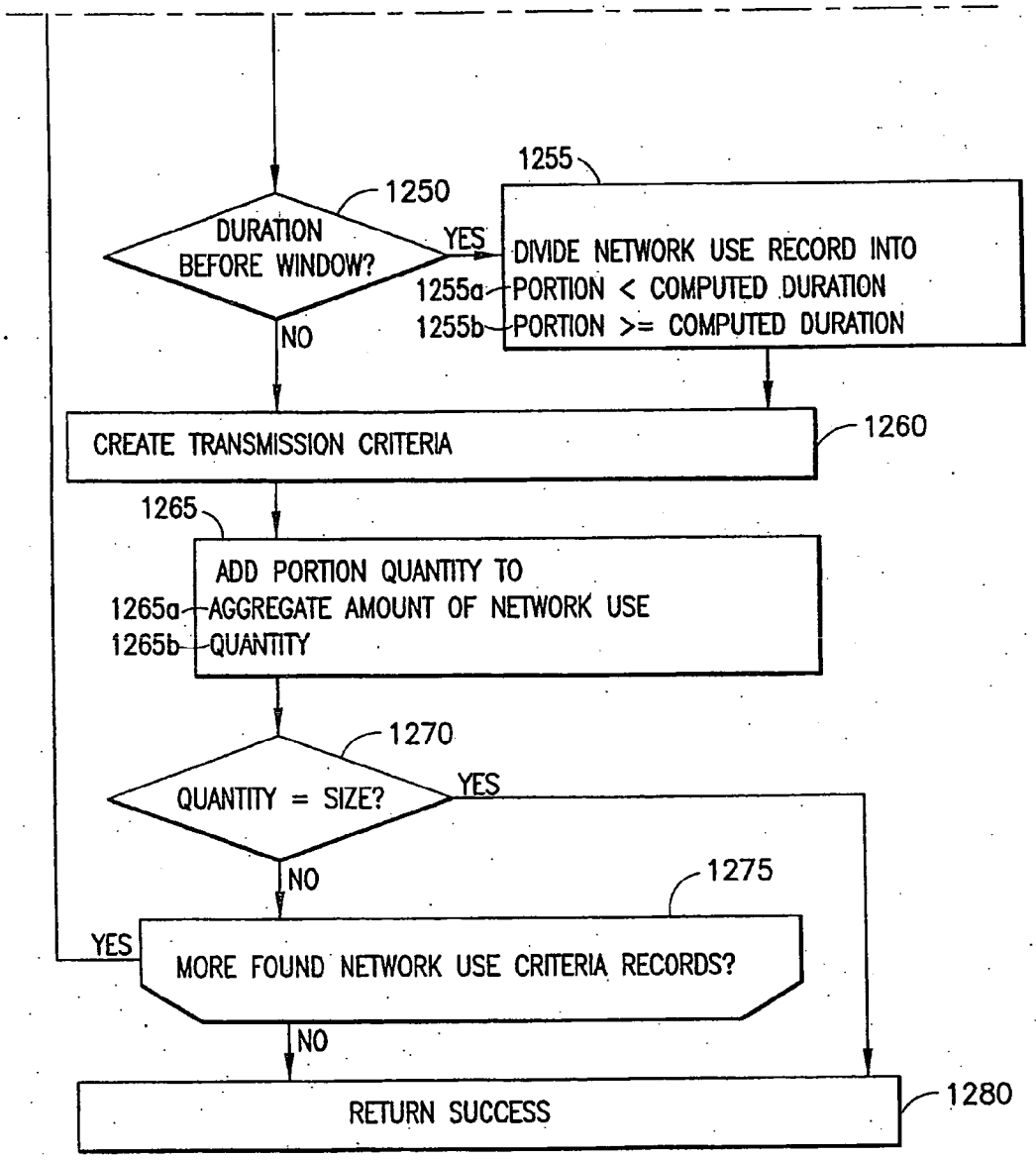

1250
DURATION BEFORE WINDOW?
YES
NO
1255
DIVIDE NETWORK USE RECORD INTO
1255a PORTION < COMPUTED DURATION
1255b PORTION >= COMPUTED DURATION
CREATE TRANSMISSION CRITERIA
1260
1265
ADD PORTION QUANTITY TO
1265a AGGREGATE AMOUNT OF NETWORK USE
1265b QUANTITY
1270
QUANTITY = SIZE?
YES
NO
1275
YES
MORE FOUND NETWORK USE CRITERIA RECORDS?
NO
RETURN SUCCESS
1280

FIG.12B

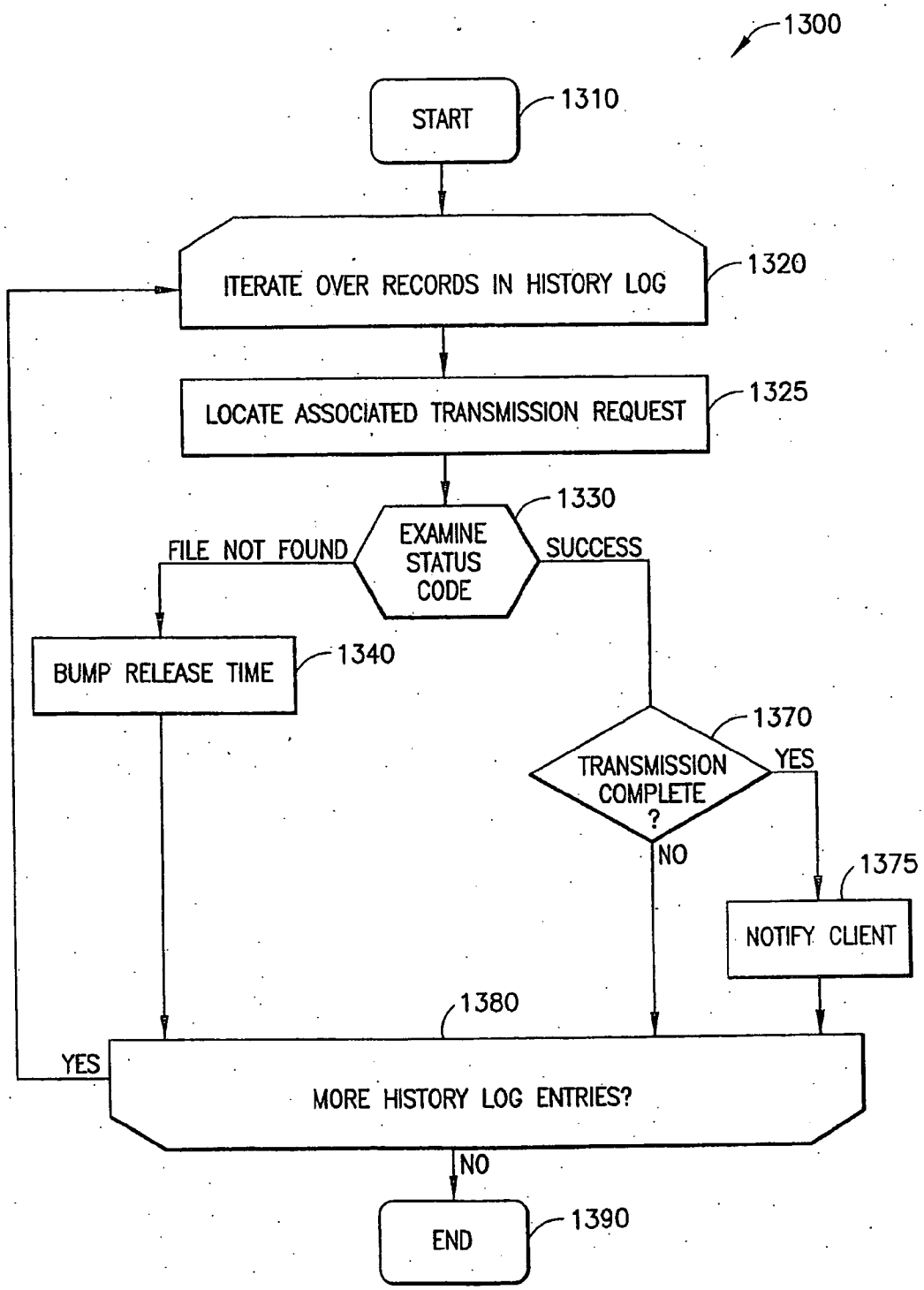

1300
START
1310
ITERATE OVER RECORDS IN HISTORY LOG
1320
LOCATE ASSOCIATED TRANSMISSION REQUEST
1325
EXAMINE STATUS CODE
1330
FILE NOT FOUND
SUCCESS
BUMP RELEASE TIME
1340
TRANSMISSION COMPLETE ?
1370
YES
NO
NOTIFY CLIENT
1375
1380
YES
MORE HISTORY LOG ENTRIES?
NO
END
1390

FIG.13

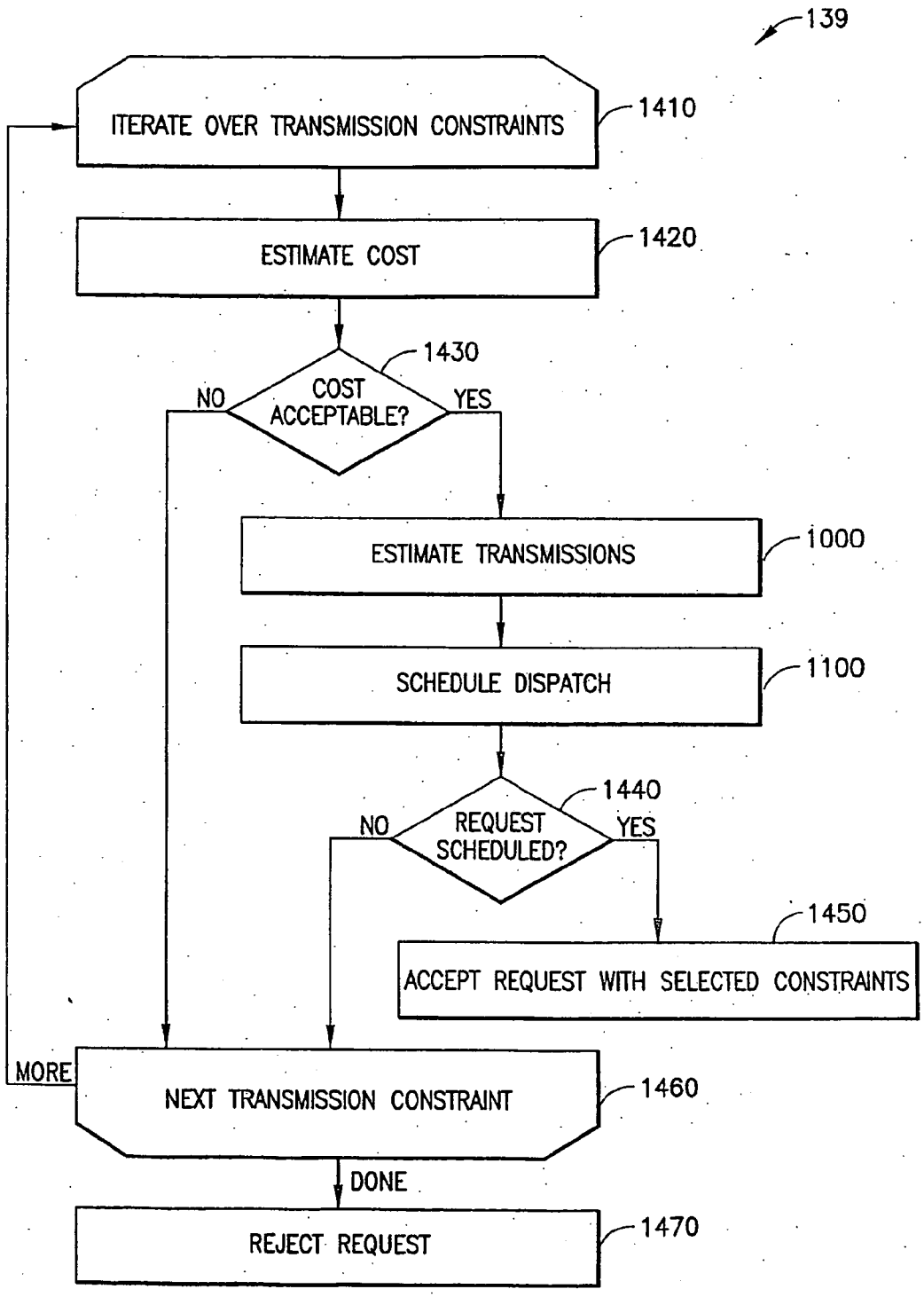

139
ITERATE OVER TRANSMISSION CONSTRAINTS
1410
ESTIMATE COST
1420
1430
COST ACCEPTABLE?
NO
YES
ESTIMATE TRANSMISSIONS
1000
SCHEDULE DISPATCH
1100
1440
REQUEST SCHEDULED?
NO
YES
1450
ACCEPT REQUEST WITH SELECTED CONSTRAINTS
MORE
NEXT TRANSMISSION CONSTRAINT
1460
DONE
REJECT REQUEST
1470

FIG. 14

METHOD OF DOING BUSINESS OVER A NETWORK BY TRANSMISSION AND RETRANSMISSION OF DIGITAL INFORMATION ON A NETWORK DURING TIME SLOTS

CROSS REFERENCE

[0001] This patent application is a divisional application of U.S. application Ser. No. 09/649,973, filed Aug. 28, 2000, the disclosure of which is incorporated by reference in its entirety.

FIELD OF THE INVENTION

[0002] This invention relates to the field of practicing a business method over a network. More specifically, this invention relates to the business of dispatching and scheduling the transmission of a information over a network.

BACKGROUND OF THE INVENTION

[0003] With the increased popularity and usage of the Internet and World Wide Web, computers are used to distribute data files (which are often large in size) over digital networks. These data files include electronic mail addressed to individuals and/or groups of people, postings for electronic bulletin boards (e.g. the usenet), pages from World Wide Web servers, audio files (encoded with MP3), video files, digital images, digitized books and diagrams, and updates and errata of digitized books and other documentation. In general, network computing is well known. For example, see U.S. Pat. No. 5,371,852 to Attanasio et al. issued on Dec. 6, 1994. This patent is herein incorporated by reference in its entirety.

[0004] For example, an insurance company may transmit many different forms of digital data to their insurance agents. The company may produce training videos and audio tapes which are digitized into video and audio data files. It may also publish its rules and regulations in digital form as web pages or digital books. Updated actuarial tables and insurance prices may be transmitted periodically. And the insurance company may use e-mail to communicate with the agents as a whole or individually. The size of these data files can vary greatly and clearly, some data files are more important than others and need to be transmitted at a higher priority or otherwise in a controlled manner. Currently, much of the prior art does not use the priority and size of documents to determine how the documents are transmitted over a network.

[0005] While many techniques and tools are used in scheduling real-time tasks for computer central processing units (CPUs), these techniques have not been applied to scheduling transmissions of data files over a network. In a real-time operating system, a computer has many jobs to run, each of which has a release time, deadline, worst-case running time, and optionally a period. The scheduler of the real-time operating system examines these job constraints and devises a schedule which allows the computers CPU(s) to operate the tasks to completion and meet the release and deadline constraints if the constraints taken as a whole are feasible. Some real-time operating system schedulers also have the ability to discard jobs on a priority basis in the event that a feasible schedule cannot be computed for the entire job set. Two well known scheduling algorithms for computing a real-time job schedule are the Earliest Deadline First (EDF) algorithm and the Rate Monotonic (RM) algorithm.

STATEMENT OF PROBLEMS WITH THE PRIOR ART

[0006] However, CPU scheduling is different than bandwidth scheduling. Bandwidth availability can vary over time—number and speed of CPU processors are constant over time. Temporary bursty congestion on network may also slow or choke data transmission. Current TCP/IP file transmission packages (FTP, HTTP) do not support scheduled pacing and preemption of data flow. TCP/IP stack and network is available only on a "first come, first served" basis. FTP and HTTP do not have scheduling capabilities to start sending the file at a given time (they just start "now").

[0007] Further, it would be desirable in some instances, that transmissions over a digital network be sent with priorities and staggered at different data rates and bursts.

[0008] Also, Quality of Service scheduling within routers and switches provides bandwidth constraints either at a packet by packet or cell by cell level. This scheduling is not applicable to multi-megabyte or gigabyte files. Queue length and other buffer resources within switches and routers are severely constrained. (In this disclosure, "packet" is used to describe any sub unit of information transmitted over a network, without the loss of generality.)

[0009] In addition, limitations of computer networks include bandwidth constraints, limited availability of shared bandwidth, network congestion, the speed of intermediate network devices (such as routers, switches, bridges, and proxy servers), and data loss to network errors.

[0010] The prior art has not adequately addressed delivering information over a network during specified time intervals.

[0011] The prior art has not been able to apply scheduling or dispatching techniques to deal with: priority information; staggered information; quality of service; queue length and buffer constraints; bandwidth constraints; and information delivery during specific time intervals. Nor has the prior art developed adequate business methods for dealing with information transmission subject to these constraints over a network.

OBJECTS OF THE INVENTION

[0012] An object of this invention is an improved business method for scheduling, dispatching, and/or transmitting information over a network.

[0013] An object of this invention is an improved business method for scheduling, dispatching, and/or transmitting information at a specific price over a network.

SUMMARY OF THE INVENTION

[0014] The present invention is a method of doing business over a network that: receives a request for transmitting digital information after a start time and before an end time, determines the time required to transmit the digital information based on the number of packets in the information and the network speed, schedules a transmit time for the digital information, and accepts the digital information for transmission only if the time required to transmit is less than or equal to the difference between the transmit time and the end time. Pricing of the transmission can be determined by the priority of transmission, whether the information is transmitted the first time or rescheduled, and whether the user receives an acknowledgment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The foregoing and other objects, aspects and advantages will be better understood from the following detailed description of preferred embodiments of the invention with reference to the drawings that are include the following:

[0016] FIG. **1** is a block diagram of a system for requesting and transmitting data files using the present invention.

[0017] FIG. **2** is a block diagram of a transmission decision list which contains transmission criteria which is used by a dispatcher process to determine when to transmit data files.

[0018] FIG. **3** is a block diagram of a file list which identifies the data files and is used by a dispatcher process.

[0019] FIG. **4** is a block diagram of the history log generated during the execution of a dispatcher process.

[0020] FIG. **5** is a block diagram of the network use criteria table which is used by a dispatcher process.

[0021] FIG. **6** is a flow chart of a dispatcher process.

[0022] FIG. **6***a* is a flow chart of an amount-to-write computation process.

[0023] FIG. **7** is a block diagram of a transmission request data structure.

[0024] FIG. **7***a* is a block diagram of an example transmission request data structure.

[0025] FIG. **8** is a block diagram of the architecture of the scheduler with an optional estimate transmissions process.

[0026] FIG. **9** is a block diagram of one preferred storage filing system.

[0027] FIG. **9***a* is a block diagram showing sample records in a delivery criteria list.

[0028] FIG. **10** is a flow chart of an estimate transmissions process which receives an accepted transmission request and its associated file and creates records in the delivery criteria list so that the file will be transmitted by the system.

[0029] FIG. **11** is a flow chart of a scheduling process using a novel network use allocation process.

[0030] FIG. **12** is a flow chart of a novel network use allocation process.

[0031] FIG. **13** is a flow chart of a feedback process.

[0032] FIG. **14** is a flow chart of an acceptance process.

DETAILED DESCRIPTION OF THE INVENTION

[0033] The present invention is a business method for doing business over a network by transmission and retransmission of digital information on a network during time slots. However, method in a preferred embodiment. These inventions are further described and claimed in U.S. patent application Ser. Nos. 09/649,954 and 09/649,953, entitled "System and Method for Dispatching and Scheduling Network Transmissions with Feedback" and "System and Method for Scheduling Digital Information Transmission and Retransmission on a Network During Time Slots", respectively, to Vogl, et al. which were filed on the same day as this invention and which are herein incorporated by reference in their entirety.

[0034] FIG. **1** is a block diagram of a system **100** containing one or more computer network dispatching process **600** (e.g. **600**A, **600**B). The system contains one or more servers (**120**, **130**, and **140**) which read information from one or more mass storage devices **110** and transmit the information over network **159** and/or other transmission means such as a radio/frequency transmitter and/or satellite **150** to one or more clients (**160**, **170**, **180**). The network **159** can be any generally known network such as the Internet, an intra net, the phone network, or a telecommunications network.

[0035] Block **120** is a dispatch server which runs the computer network dispatcher process **600** (**600**A, **600**B). This process **600** is described in detail in FIG. **6** below. The dispatch server **120**, optionally, runs a scheduler process **128** and a billing process **129**. The dispatch server **120** has one or more memories **126** which contain a transmission decision list **200**, a file list **300**, a file transmission history log **400**, and an optional network use criteria table **500**. These lists (**200**, **300**, **400**, **500**) are described in detail in FIGS. **2**, **3**, **4**, and **5**, below, respectively. System time **125** is a clock which provides timing information to the dispatch server **120**.

[0036] Blocks **124**A and **124**B are network buffers which buffer information to be written from the dispatch server **120** to its network connections, **122**A, **122**B. Each network buffer **124**A, **124**B has an available space measure, typically **123**, which is an indication of how much information the buffer (**124**A, **124**B) can hold before overflowing. The measure of available space **123** in the network buffers **124**A, **124**B will change over time as information is written into the network buffers **124**A, **124**B by the dispatching process **600** and other processes which may be sharing the network buffers **124**A, **124**B. The available space measure **123** will also change as information within the network buffers **124**A, **124**B is transmitted to connected computer networks **150**, **159**. Many factors limit the amount of information which can be transmitted at any point in time. These factors can include the network speed, the bandwidth of the network, congestion of the network, and availability of the network. Certain network resources, such as satellite **150** time, may be available on a scheduled basis, and their network parameters (e.g. cost, pricing, speed, bandwidth) may vary depending on a time of day.

[0037] Block **110** is a mass storage device. In a preferred embodiment, this mass storage device **110** is a disk drive. In alternative embodiments, the storage device **110** could be one or more disk drives, magnetic tape drives, memories, or optical drives (e.g. CD-ROM, DVD). The mass storage device **110** contains a file system **112** containing zero or more files **112**A and a database **113** which contains zero or more delivery criteria lists **114**. The file system **112** and database **113** hold the information which the computer network dispatching process **600** writes onto the computer networks **150**, **159** through the network buffers (**124**A, **124**B). The mass storage device **110** is connected **116** to the dispatch server **120**. In a preferred embodiment, this connection **116** is made via a Small Computer System Interface (SCSI) connection. In alternative embodiments, the connection **116** could be a network connection or any other connection used for transmitting data. The connection **116** serves as an input to the dispatch server **120** for accessing the files **112**A and databases **113** of the mass storage device **110**. Connections **116** may also exist between the mass storage device **110** and the optional schedule server **130** and request server **140**.

[0038] Block **130** is an optional scheduling server. This server **130** runs a scheduler process **134**, an acceptance process **139**, a delivery status process **137**, and, optionally, a billing process **136** and analysis process **138**. The scheduler process **134** (and the optional scheduler process **128** of the dispatch server **120**) schedules one or more portions of the files **112**A in the mass storage **110** file system **112** for transmission by the dispatch server **120** via its network buffers **124**A, **124**B.

[0039] The scheduler process **134** (**128**) does this by writing a transmission decision list **200** and a file list **300** in the memory **126** of the dispatch server **120**. The file list **300**

associates files **112**A in the file system **112** with the network buffer **124**A. The transmission decision list **200** provides transmission criteria **250** (e.g. pacing, timing, and portioning information) about the transmission of the files **112**A.

[0040] The optional billing processes (**129**, **136**) of the dispatch server **120** and the scheduling server **130** monitor the progress of the dispatching process **600** (**600**A, **600**B) and examine statistics stored in the dispatching process **600** history log **400** and network use criteria table **500** in order to determine a cost of a file transmission. Optionally, an analysis process **138** also examines these statistics (**400**, **500**) to test for conformance of the dispatching processes **600** to the schedule defined by the scheduler process **134** and for overall system monitoring and activity charting. In a preferred embodiment, the outputs of the billing process **136** and analysis process **138** are stored in a database **113**.

[0041] The scheduling server **130** contains a memory **131** which contains zero or more transmission requests **700**. The transmission requests **700** contain scheduling constraints and information regarding the transmission of information files **112**A. Transmission requests **700** are discussed in FIG. **7**, below.

[0042] The acceptance process **139** is a process which determines if it is possible to schedule a transmission of a file **112**A in accordance with the information in a transmission request **700**, taking into consideration network use availability, as recorded in the network use criteria table **500**, and other pending transmission requests **700**. The acceptance process **139** is described in FIG. **14**, below.

[0043] The delivery status process **137** is a process which takes an action (such as notifying a system operator, or a client **160**, **170**, **180**) when the system **100** determines that it cannot meet the scheduling constraints of an accepted transmission. The delivery status process **137** is described in FIG. **8**, below.

[0044] Block **140** is a request server which contains a request receiver process **144** and a content generator process **146**. The request receiver process **144** and content generator process **146** are interfaces by which a request client **180** can request the insertion of files **112**A into the file system **112**, request the transmission of files **112**A, view the history logs **400** and network use statistics **500** generated by the dispatch server **120**, and view the outputs of the billing process **136** and analysis process **138**. In a preferred embodiment, the request receiver process **144** and content generator process **146** are web servers and receive/transmit information from/to a request client **180** via the well known Hypertext Transfer Protocol (HTTP) protocol. In an alternate embodiment, the request receiver process **144** interacts with a request client **180** via the Simple Network Management Protocol (SNMP) protocol and the content generator process **146** interacts with a request client **180** via the File Transfer Protocol (FTP) protocol. The request receiver process **144** and content generator process **146** may alternatively interact with a request client **180** via a non-real time protocol such as e-mail or message queues. Block **142** of the request server **140** is a network connection. The network connection **142** provides a connection to a network **159** which is also accessible in real time or non-real time to the client **180** and, optionally, clients **160**, **170**.

[0045] The request server **140** also contains a transmit time process **147** which determines the time requested to transmit a file **112**A based on its size, the network speed, the time of day, the size of the network buffers (**124**A, **124**B), and information in the transmission request **700** associated with the file **112**A. This process **147** is described in the network use allocation process **1200**, FIG. **12** below, specifically in step **1235**.

[0046] Note that servers **120**, **130**, and **140** can be combined or distributed over one or more computers. Scheduling processes **128** and **134** may also be combined or distributed over one or more computers. Billing processes (**129**, **136**), analysis processes **138**, acceptance processes **139**, delivery status process **137**, request receiver processes **144**, transmit time processes **147**, and/or content generator processes **146** may also be combined or distributed.

[0047] Blocks **150** and **159** are two types of computer networks. Block **159** is an internet/intranet network. Internet/intranet networks **159** are well known and consists of one or more interconnected switches **153**, bridges **154**, routers **155**, and proxies **156**. The intranet/internet network **159** passes digital messages and transmissions between servers (e.g. **120**, **140**) and connected clients (e.g. **170**, **180**). Each connected server (**120**, **140**) and client (**170**, **180**) has a network connection (**122**B, **142**, **172**, **182**, respectively) to the network **159**. Line **157** represents the network links between the network connection (**122**B, **142**, **172**, **182**) and the internet/intranet network **159**. These network links **159** are typically telephone lines, cable networks, or wireless networks.

[0048] Blocks **150**, **151**, **152** and **158** form a broadband satellite network. Digital data is carried over a network link **158** to a satellite transmitter **151** where it is modulated into radio-frequencies (RF) and broadcast into the sky to be reflected/rebroadcast by an orbiting satellite **150**. The reflected/rebroadcast RF encoded data is received at satellite receivers **152**, demodulated into digital data, and transmitted over a network link **158** to a satellite client **160**. Blocks **122**A and **162** are network connections which connect their respective hosts (dispatch server **120** and satellite client **160**) with the network links **158** of the broadcast satellite network **150**. As a non-limiting example of a network connection **162**, see U.S. Pat. No. 6,021,419 to Clarke et al. issued on Feb. 1, 2000. This patent is herein incorporated by reference in its entirety.

[0049] Blocks **160** and **170** are satellite clients and internet clients, respectively. These clients (**160**, **170**) receive information transmitted through the network buffers **124**A, **124**B of the dispatch server **120** and onto the respective connected computer networks (**150**, **159**) by the dispatching process **600**. Each client (**160**, **170**) has a network buffer (**164**, **174**) which buffers information received from the connected computer network (**150**, **159**) and a receiving process (**166**, **175**) which performs an action on the received information.

[0050] The satellite client **160** is connected to the satellite network **150** via network connection **162**. It receives information transmitted by the dispatch server **120** through network buffer **124**A. Through well know protocols, after the dispatching process **600** writes information into the network buffer **124**A, that information will be digitally sent to satellite transmitter **151** and modulated into RF. The RF encoded information will be reflected/rebroadcast by satellite **150** and received by satellite receiver **152** to arrive in digital form at network connection **162**. The information will then enter the network buffer **164** of the satellite client **160**. The receiving process **166** will be alerted to the presence of the received information in the network buffer **164** and will take an appropriate action.

[0051] Similarly, internet/intranet client **170** is connected to internet/intranet **159** via network connection **172**. It receives information transmitted by the dispatch server **120**

through network buffer **124**B. Through well known protocols, after the dispatching process **600** writes information into the network buffer **124**B, that information will flow through the internet/intranet network **159** to arrive at network connection **172**. The information will then enter the network buffer **174** of the internet/intranet client **170**. The receiving process **175** will be alerted to the presence of the received information in the network buffer **174** and will take an appropriate action. The actions of the internet/intranet client **170** receiving process **175** and the satellite client **160** receiving process **166** could include: decoding the information into an audio wave form and playing it over a speaker **176**; decoding the information into a video presentation and displaying it on a monitor **177**; displaying the information as a web page on a monitor **177**; and/or storing the information on a mass storage device **178**.

[0052] Block **180** is a requesting client which has a network connection **182** to internet/intranet network **159**. Client **180** has a request process **186** which communicates to the request receiver process **144** through network buffer **184** and connected network **159**. This process **186** creates transmission requests **700** which are sent to the request receiver process **144** to schedule transmissions of a file **112**A. The client **100** may contain an optional mass storage **188** which holds files **112**A which are accessed by the content generator process **146** for storage and transfer to the file system **112** of mass storage **110**.

[0053] FIG. **2** is a block diagram of the transmission decision list **200** data structure. The transmission decision list **200** is a sequence of zero or more transmission criteria **250** that instruct the dispatching process **600** (**600**A, **600**B) about how, when, and at what burst rate, a file **112**A should be transmitted over a network (**150**, **159**). The transmission criteria **250** data structure contains the following fields: an index **205**, a release time **210**, a portion quantity **215**, a duration **220**, a burst size **225**, a burst rate **230**, a quantity completion measure **235**, and a status code **240**.

[0054] The index field **205** contains a reference into the file list **300** described in FIG. **3** below. Each value in a transmission criteria **250** index field **205** should refer to exactly one file list record **350**. In a preferred embodiment, the index field **205** contains a numeric integer value. In alternate embodiments, the index field **205** can contain a numeric identifier, an alphanumeric identifier such as a filename) or a memory address. Note that multiple transmission criteria **250** may have index fields **205** which refer to the same file list record **350**.

[0055] The portion quantity **215** field defines the quantity of the portion of the indexed **205** file **112**A, that the dispatching process **600** should transmit. In a preferred embodiment, the portion quantity **215** field holds a byte count (e.g. 64000 bytes). In alternative embodiments, the portion quantity **215** field could hold a percentage (e.g. 10%). The release time **210** field indicates the minimum time at which the respective portion of the indexed **205** file **112**A should be written to the network buffer (**124**A, **124**B) by the dispatching process **600**. The duration **220** field establishes an end time beyond which no more of the portion is written to the network buffer (**124**A, **124**B) by the dispatching process **600**. In a preferred embodiment, both the release time **210** field and the duration **220** fields hold time stamp values. In an alternate embodiment, the duration **220** field could hold a number which indicated an offset (perhaps in seconds) against the release time **210**. Hence, these three fields **210**, **215**, **220** of the transmission criteria **250** data structure define the size of a portion and an interval during which the dispatching process **600** should transmit the respective portion.

[0056] Note that in a preferred embodiment, the portion quantity **215** is included in the transmission criteria **250** but a value indicating where portion begins in the file **112**A is not specified. As described below, the dispatching process **600** reads each portion from the files **112**A starting with the value located in the cursor **315** field of the file list **300**. As information within the portion is transmitted, the cursor **315** field is increased accordingly. The dispatching process **600** does this so that as portions of a file **112**A are transmitted over a network buffer, e.g. **124**A, the information transmitted will be contiguous within the file **112**A. That is, there will be no gaps from one portion to another if, due to excessive load on a network, e.g. **150**, the dispatching process **600** is unable to write an entire portion quantity **215** amount of information into the network buffer during the time interval specified by the release time **210** and duration **220**.

[0057] The burst size **225** and burst rate **230** fields of the transmission criteria **250** data structure are used to specify limits on the amount of a portion written into a network buffer (**124**A, **124**B) at any specific time. Together, the burst size **225** and burst rate **230** fields provide pacing information to the dispatching process **600**. The dispatching process **600** will partition the respective portion of the file **112**A into quantities of a size no greater than the burst size **225** and each quantity will be written to its respective network buffer (**124**A, **124**B) at a time interval not less than the burst rate **230**. This pacing information can be used to lessen the chance of information loss through the network (**150**, **159**) when, for example, the network buffer (**124**A, **1224**B) of the dispatching server **120** is of a different size than the network buffer (**164**, **174**) of a connected client (**160**, **170**). Or when the receiving process (**166**, **175**) and/or the network buffers (**164**, **174**) of a client cannot receive an entire portion quantity **215** of information in one transmission. The burst size **225** and burst rate **230** fields are optional.

[0058] The index **205**, release time **210**, portion quantity **215**, duration **220**, burst size **225**, and burst rate **230** fields of the transmission criteria **250** data structure provide input data to the dispatching process **600**.

[0059] The quantity completion measure **235** and status code **240** fields of the transmission criteria **250** data structure are filled in, over time, with an output of the dispatching process **600**. As the dispatching process **600** writes portions, or quantities of partitioned portions, into a network buffer (**124**A, **124**B) for transmission, the dispatching process **600** a quantity completion measure **235** will be accumulated. In a preferred embodiment, the quantity completion measure **235** field holds a byte count of information within the partition transmitted. When the value in the quantity completion measure **235** field is equal to the value in the portion quantity **215** field, the portion has been completely written into the network buffer (**124**A, **124**B). The quantity completion measure **235** and status code **240** fields are optional.

[0060] The status code **240** field of the transmission criteria **250** data structure can take on one of the following values: "Pending", "Active", "Complete", and "Timed out". This field **240** indicates state of the partition in the transmission criteria **250** data structure. If the status code **240** field has a "Pending" or "Active" value, the partition specified by the transmission criteria **250** is available to be written into the network buffer **124**A, **124**B by the dispatching process **600**

(within the time interval specified by the release time **210** and duration **220** fields). A "Complete" value in the status code indicates that the dispatching process **600** has completed the writing of the partition into the network buffer **124**A, **124**B. And a "Timed out" status code **250** value indicates that the dispatching process **600** was unable to write the entire portion quantity to the network buffer **124**A, **124**B before the duration **220** elapsed. The status code **240** field has an initial value of "Pending". In alternative embodiments, the status code **240** field may also take on additional, and more specific, values such as codes indicating mass storage media errors (i.e. parity errors, disk errors), network errors, destination not found errors, and destination not responding errors.

[0061] FIG. **3** is a block diagram of the file list **300** data structure. The file list **300** is a sequence of zero or more file list records **350** that correlate one or more transmission criteria **250** with individual files **112**A within the file system **112** of the mass storage **110**. The file list record **350** data structure contains the following fields: an index **305**, a source file identifier **310**, an (optional) cursor **315**, a destination address **320**, and a transmission type **325**. The file list records **350** identify files **112**A in the mass storage **110** that are to be transmitted over one or more of the computer networks (**150**, **159**) connected to a respective network buffer (**124**A, **124**B). The file list records **350** also serve to associate the files **112**A with the portioning information defined in the transmission criteria **250**.

[0062] The index **305** field holds a value which uniquely distinguishes a file list record **350** from other file list records **350** in a file list **300**. In a preferred embodiment, the index **305** field holds an integer value. In alternate embodiments, the index **305** field can hold some other type of unique value such as a file name or other mass storage identifier and may also share the same value as the source file identifier **310** field. Or, the index **305** field may be the address in the memory **126** of the dispatching server **120** where the file list record **350** is located. The index **305** field is used as a cross reference to the index **205** field in transmission criteria **250** as described above.

[0063] The source file identifier **310** field associates the file list record **350** with a file **112**A in mass storage **110**. In a preferred embodiment, the source file identifier **310** field contains a handle value through which the dispatching process **600** can read information from a file **112**A in mass storage **110**. In alternative embodiments, the source file identifier **310** field could contain a file name (e.g. "C:\Data\Video.MPG"), a TCP/IP socket identifier, or a memory address of a computer process which delivered file information as its output.

[0064] Hence, through the index **305** field and the source file identifier **310** field, the file list record **350** provides an association between transmission criteria **250** and files **112**A.

[0065] The optional cursor **315** field of the file list record **350** is used when the information of a file **112**A is available in a random access mode. The values of the cursor **315** field indicate where information should be read from, by the dispatching process **600**, in the identified **310** file **112**A. As information is read and transmitted to network buffers (**124**A, **124**B), by the dispatching process **600**, the dispatching process **600** (**600**A, **600**B) will update the value in the cursor **315** field. In a preferred embodiment, the cursor **315** field contains integer values with zero being a "beginning of file" value. In alternate embodiments, the cursor **315** field may contain memory addresses or other values appropriate to the type of mass storage **110** in use. When the file **112**A can only be read in a serial manner (i.e. is not read in a random access manner), the cursor **315** field is omitted from the file list record **350** data structure.

[0066] The destination address **320** field of the file list record **350** identifies one or more network buffers (**124**A, **124**B) that the dispatching process **600** should write the associated portioned **250** file **112** information into. The destination address **320** field may further identify one or more network connected client (**160**, **170**) machines which will receive the portioned **250** file **112**A information. In a preferred embodiment, the destination address **320** field holds an internet multicast address.

[0067] The transmission type **325** field identifies the protocol to be used by the dispatching process to transmit the portioned **250** file **112**A information. Transmission types can include the well known unicast, multicast, broadcast, internet protocol (IP), IPX, asynchronous transfer mode (ATM), UDP, and TCP/IP protocols.

[0068] FIG. **4** is a block diagram of the history log **400** data structure. The history log **400** is a sequence of zero or more history records **450** which provide an accumulated amount of one or more of the portions **250** of files **112**A transmitted over one or more of the computer networks **150**, **159** by the dispatching process **600** in an interval. The history log record **450** data structure contains the following fields: an index **405**, a start time stamp **410**, a status code **415**, a completion time stamp **420**, and a quantity completion measure **425**. The history log **400** is an output of the dispatching process **600**.

[0069] The index **405** field of the history record **405** holds a value equal to a value of an index **305** field in a file list record. The start time stamp **410** and completion time stamp **420** fields define a time interval. And, the status code **415** field and quantity completion measure **425** fields are progress indicators which hold a success value and an accumulated amount of portions transmitted by the dispatching process **600** during the specified interval (**410**, **420**). In a preferred embodiment, the status code **415** field can hold the same values as the status code **240** field in the transmission criteria **250** data structure. Similarly, the quantity completion measure **425** field is of the same data type as the quantity completion measure **235** field of the transmission criteria **250** data structure. In alternative embodiments, the progress indicators (**415**, **425**) may hold multiple values, e.g. multiple status codes.

[0070] During its execution, the dispatching process **600** progressively populates the history log **400** with history records **450**. Study of the growing history log **400** of history records **450** can provide analysis processes **138** and/or billing processes (**129**, **136**) with statistics about the progress of file **112**A portion **250** transmissions and the computer networks (**150**, **159**). Parts of the cumulative history log **400** may also be offloaded from the memory **126** of the dispatching server **120** and stored in mass storage **110** for off-line analysis in a preferred embodiment, the dispatching process **600** populates the history log **400** with a history record **450** each time an amount of portioned **250** information is written into a network buffer (**124**A, **124**B). In alternative embodiments, the dispatching process **600** may populate the history log **400** less frequently, perhaps on a timed basis (e.g. create cumulative history records **450** each minute or hour of activity).

[0071] FIG. **5** is a block diagram of an optional network use criteria table **500**. The network use criteria table **500** is a sequence of zero or more network use criteria records **550** which specify a maximum value of network resource that is to

be used by the dispatching process **600** (**600**A, **600**B) in a given interval of time. The network use criteria record **550** data structure contains the following: a time stamp **505** field, a defined network use **510** field, an aggregate amount of network use **515** field and an optional network identifier **520** field. The network use criteria record **550** data structure may also contain a network use window **525** field and a remaining bandwidth **530** field.

[0072] The defined network use **510** field is used to constrain the dispatching process **600** to use a limited amount of network resource (e.g. bandwidth) starting at a time specified in the time stamp **505**. In a preferred embodiment the defined network use **510** field defines a maximum amount of the information stored in the files **112**A which should be written to a network buffer (**124**A, **124**B) after a specific time **505**. As information is written into the network buffers (**124**A, **124**B) by the dispatching process **600**, the dispatching process **600** will maintain a count of the network resources (e.g. bandwidth) used in the aggregate amount of network use **515** field.

[0073] The network use criteria table **500** is most useful when resources of a computer network (e.g. **150**) resources, such as satellite **150** time, are be available on a scheduled basis, and network parameters (cost, speed, bandwidth) vary depending on time of day. For example, a satellite uplink facility may lease satellite network **150** bandwidth at 45 Mbps between 4:00 AM and 5:00 AM and 15 Mbps at all other times of the day. To accommodate these constraints in the system **100**, a network use criteria table **500** containing twenty-four network use criteria records **550** could be constructed on a daily basis. The twenty-four network use criteria records **550** could contain successive time stamp **505** values ranging from 0:00 (midnight) to 23:00 (11:00 PM). The network use criteria record **550** which had a time stamp **505** value of 04:00 AM could have defined network use **510** value of 45 Mbps×60×60 (i.e. the amount of bandwidth available in that one hour). The other network use criteria records **550** could have a defined network use **510** value of 15 Mbps×60×60.

[0074] The aggregate amount of network use **515** values written by the dispatching process **600** may be recorded as a supplement to the history log **400** and stored in mass storage **110** for analysis purposes.

[0075] The optional network use window **525** field is used to indicate the length of the interval of time the network use is defined **510** for. In a preferred embodiment, this field **525** does not exist in the network use criteria record **550** data structure, but a value for this field **525** is computed on demand. The network use window **525** is a virtual field. The virtual network use window field **525** value being the time interval between the time stamp **505** of the network use criteria record **550** and the time stamp **505** of the network use criteria record **550** with the next greater time stamp **505**. In alternate embodiments, the network use window **525** field may exist in the network use criteria record **550**, e.g. occupy memory. In other alternate embodiments, an end time stamp **505** may be used in place of an interval window **525**.

[0076] The optional remaining bandwidth **530** field is used to indicate an amount of available bandwidth which is available during the time period specified by the network use criteria record **550**. In a preferred embodiment, the remaining bandwidth field **530** is a virtual field and its value is computed on demand. The virtual remaining bandwidth field **530** has a value equal to the difference between the defined network use **510** and the aggregate amount of network use **515** divided by the network use window **525**.

[0077] The network use window **525** and remaining bandwidth **530** fields are used in the network use allocation process **1200**, FIG. **12** below, in order for the network use allocation process **1200** to tentatively reserve portions of network use.

[0078] The optional network identifier **520** field is used to identify which computer network **150**, **159** the network use criteria record provides constraints against when the dispatching server **120** is connected to two or more computer networks, each with possibly differing constraints.

[0079] The dispatching process **600** (**600**A, **600**B) uses the data structures described above (**200**, **300**, **400**, **500**) to transmit portions of one or more files **112**A over the network (**150**, **159**) on a scheduled basis. And, to provide feedback to processes (e.g. Scheduler process **128**, **134**, billing process **136**, analysis process **138**) indicating the progress of each file **112**A portion transmission over time.

[0080] FIG. **6** is a flowchart of a dispatching process **600** (**600**A, **600**B) called the Dispatch State Machine with Feedback for Scheduled Transmissions. This process **600** transmits files **112**A over a computer network (**150**, **159**) based upon transmission criteria **250** contained in a transmission decision list **200**. The process begins **605** by selecting the transmission criteria **250** entry on the transmission decision list **200** with the earliest release time **210** and a status code **240** which is either "Pending" or "Active". The dispatching process **600** then examines **610** the (optional) duration field **220** of the selected transmission criteria **250**. The value in the duration field **220** is compared against the current time of the system clock **125**. If the duration **220** has passed, step **615** stores a "Timed Out" value in the status code **240** field of transmission criteria **250** and execution of the process **600** continues to step **675** where a next iteration **605** of the dispatching process **600** (**600**A, **600**B) is begun.

[0081] If the duration **220** has not passed, the dispatching process **600** continues to step **620** where the process **600** pauses in an idle state until the release time **210** of the transmission criteria **250** has passed. In a preferred embodiment of the process **600**, this pause **620** may be interrupted when a new entry **200** is inserted into the transmission decision list **200** which has a release time **210** earlier than the currently selected transmission criteria **250** or when an existing entry of the transmission decision list **200** is modified so that its release time **210** is earlier than that of the currently selected transmission criteria **250**. When the process **600** is interrupted in this manner, execution returns to step **605**. This idle step **620** allows the dispatching process **600** to (a) support schedules which are non-work conserving, (b) ensure that transmissions will not be initiated prematurely before their specified release times **210**, and (c) allow the throttling of transmissions to an arbitrarily specified burst rate **225** and burst size **230**.

[0082] For example, a transmission decision list **200** may contain a transmission criteria entry **250** with a release time **210** of 05:00 hours. If, during the execution of process **600**, this entry **250** is selected at 04:45 hours, the process **600** will idle at step **620** for fifteen minutes. During this idle period the process **600** will write no data to the network even though there are entries in the transmission decision list **200** and thus will be non-work conserving (a). Execution of the process **600** will not resume until 05:00 hours and therefore the portion defined by the transmission criteria **250** with a release time of 05:00 hours will not be transmitted prematurely (b).

[0083] Similarly, suppose that a transmission criteria **250** contains a burst size field **225** of 10 Kbytes and a burst rate field **230** of 00:01 hours (one minute). After a first amount of data is written by process **600**, the transmission criteria **250** will be rescheduled, step **670**, with a release time **210** one minute greater than the first release time. This will cause step **620** to idle until one minute has elapsed and limit the burst rate of the transmission (c).

[0084] When the release time **210** of the selected transmission criteria **250** has arrived (or has past), the dispatching process **600** checks for availability of bandwidth, step **625**. A network use criteria record **550** is chosen from the network use criteria table **500**, and the defined network usage **510** is compared against the aggregate amount of network usage **515** to determine a network resource availability. In a preferred embodiment, the defined network usage **510** field and the aggregate amount of network usage **515** fields hold integer amounts of bandwidth. Equal values of the two fields (**510**, **515**) indicate that there is no available bandwidth, and upon finding equal values, the process moves into a second idle state **630**. The process **600** will idle **630** until the time specified in the time stamp **505** field of the next entry of the network use criteria table **500**. After the idle time of step **630** has elapsed, execution resumes to step **685** and then step **605** where a second iteration of the dispatching process **600** is begun.

[0085] The network use criteria record **550** is chosen from the network use criteria table **500** by selecting the record in the network use criteria table **500** which has the greatest time stamp field **505** that is less than or equal to the time of the system clock **125**. By using the system clock **125** as an index into the network use criteria table **500**, the dispatching process **600** can operate on and take advantage of computer networks, e.g. **150**, where the network resources available varies over time.

[0086] Refer now to FIG. **6**A which is a flow chart of an amount-to-write computation process **635**A.

[0087] The dispatching process **600** continues **635** by computing an amount of data **635** to write. This amount **635** will be used by the process **600** during the reservation and write steps (**640**, **645** respectively) described below when the process **600** writes information into a network buffer **124**A, **124**B. In a preferred embodiment, the amount **635** is the minimum (e.g. byte length) **636** of the following values: (a) the quantity of network resources currently available **510** less the aggregate amount of network use **515** in the network use criteria table **500**; (b) the portion quantity **215** value stored in the currently selected transmission decision list entry **200**; (c) the burst size **225** value also from the currently selected transmission decision list entry **200**. Each of these fields (**515**, **215**, **225**) can have optional "not-specified" values which indicate that no number is given in the respective field. Fields which contain the not-specified value are ignored for purposes of calculating the amount of data **635** to write. In alternate embodiments, these fields (**515**, **215**, **225**) are optional and may be ignored during the calculation **635**. An embodiment may also include (d) the available space **123** in a network buffer (**124**A, **124**B) as a further factor in the minimum calculation.

[0088] The portion quantity **215** value of the transmission criteria **250** is chosen as a candidate for the amount of data to write **635** because it indicates the maximum total amount of data which should be transmitted for the transmission decision list entry **200**. This value may be smaller than the burst size **225** and the network resources available **510**, **515**. If the process **600** were to write more than quantity to write 215 bytes, the process could read past a buffer, encounter an end-of-file error, or write more data than the transmission criteria **250** called for.

[0089] The burst size **225** value of the transmission criteria **250** is chosen as a candidate for the amount of data to write **635** because it indicates the amount of data which should be transmitted for the transmission criteria **250** during a burst rate **230** interval. The process **600** will not write more than burst size 225 bytes for any transmission during a burst rate **230** interval. The process **600** paces itself in this manner so as not to overwhelm the networks **150**, **159** with data and so that network buffers in the server computer (**124**A, **124**B), network devices at intermediate points (e.g. proxies **156**, routers **155**, switches **153**, bridges **154**), and receiving buffers (**164**, **174**) and receiving processes (**166**, **175**) in client computers (**160**, **170**) will be able to handle the network load.

[0090] Now refer back to FIG. **6**.

[0091] After computing the amount to write **635** value, the dispatching process **600** then **640** reserves bandwidth from the network use criteria table **500**. In a preferred embodiment this reservation is done by increasing the aggregate amount of network use **515** field of the network use criteria record **550** selected in step **625** by the amount to write value **635**. In alternate embodiments the reservation may be performed using a second table or other data structure. This reservation prevents two or more instances of this process **600** which may be running concurrently from writing more data to a network (**150**, **159**) than it can handle.

[0092] The dispatching process **600** then proceeds **645** to write data into a network buffer (**124**A, **124**B). The process **600** does this by locating the file list record **350** in the file list table which has a file list index **305** that is equal to the index **205** in the selected transmission criteria **250**. Data is then read from the file **112**A referenced by the source file identify **310** starting at the location specified by the cursor **315**. The read data is written to the network buffer (**124**A, **124**B) identified by the destination address **320**, optionally, accompanied with the destination reference **320**. The amount to write value computed in step **635** is used to place a limit on how much data is written at this step **645**. In a preferred embodiment, the data is written in a non-blocking manner so that execution of the dispatching process **600** will not be delayed by a block waiting for a network buffer **124**A, **124**B to clear. The dispatching process **600** also maintains a timer and monitors the elapsed time of the write operation **645**. If the time of the system clock **125** passes the duration **220** specified in the transmission criteria **250** or the elapsed time exceeds the burst rate **230**, the process cleanly preempts (rather than aborting) its write operation **650**. In alternate embodiments, the process **600** may also conditionally interrupt the write operation **650** when the transmission criteria **250** is modified by a second process (i.e. a scheduler).

[0093] When its write operation **645** completes (normally or preemptively), the dispatching process **600** updates fields **655** within the transmission criteria **250**, the file list record **300**, and the network use criteria record **550** to reflect the transmission (writing of data step **645**). Within the selected transmission criteria **250**, the portion quantity field **215** is decremented by the amount of data written (which may be less than the value computed in step **625** if the write operation was interrupted), and the quantity written field **235** is incremented by the same amount. The cursor **315** field in the

selected file list record **350** is incremented by the amount of data written. And within the selected network use criteria record **550**, the aggregate amount of network use **515** is decremented by the difference between the amount of resources used and the amount of network resources estimated by the amount of data to write **625** (in order to give back any unused resources previously reserved in step **640**).

[0094] The dispatching process **600** then **660** edits the history log **400** to record the transmission **645** event. Step **650** appends a new history record **450** is appended to the history log **400**. The index field **205** value of the selected transmission criteria **250** is copied into the history record **450** index **405**, the time reading from the system clock **125** in step **625** is copied into the start time stamp field **410**, the time reading from the current system clock **125** is copied into the completion time stamp field **420**, and the amount of data written in step **635** is recorded into the quantity completion field **425**. Further, a status code (e.g. "Success", "Preempted due to duration", "Preempted due to transmission criteria modification", "Preempted due to network error", "Preempted due to disk error", "File not found", . . .) is written into the status code field **415**.

[0095] These two steps (**655**, **660**) allow other processes (e.g. Schedulers **128**, **134**, billing **129**, **136**, analysis processes **138**, and feedback processes **1300**, described in FIG. **13** below) to monitor the progress of file transmissions. By updating the history log **400**, the dispatching process **600** can provide feedback to a scheduler (**128**, **134**) so that it can dynamically reschedule transmissions due to delays in the network or due to unexpected increases in network bandwidth. Analysis processes **138** may also use this information to check the network and state machine for conformance to and variances from a defined schedule. These other processes may also monitor changes made by the dispatching process **600** to the transmission criteria **250** and file list records **350**.

[0096] The dispatching process **600** then, step **665**, examines the portion quantity **215** field of the transmission criteria **250**. If the portion quantity **215** field has a value of zero, step **680** marks the status code field **240** of the transmission criteria **250** as "Complete" and the dispatching process **600** will no longer select the transmission criteria **250** during step **605**. Execution of the process **600** continues to step **685** and to step **605** where a next iteration of the process begins.

[0097] If the portion quantity **215** field of the transmission criteria **250** contains a non-zero value, step **670** marks the status code **240** field "Active" and transmission criteria **250** remains a candidate for selection in step **605**. If an optional burst rate **230** was specified in the transmission decision list entry **200**, the release time **210** field is incremented by the burst rate **230** in step **675**. This will cause the dispatching process **600** to not transmit any more data for this transmission criteria **250** until the duration of time specified in the burst rate **230** has passed **620**. Execution of the process **600** continues to step **685** which is simply a jump to the start of the process **600**, step **605**, where a next iteration of the process **600** will commence.

[0098] FIG. **7** is a block diagram of a transmission request **700**. Transmission requests **700** are received from a client **180** by the request receiver process **144**, described in FIG. **1** above. In a preferred embodiment, a message containing a transmission request **700** is sent from the client **180** to the request receiver process **144** via HTTP (the Hypertext Transport Protocol). The transmission request **700** data structure contains information which instructs the schedule architecture **800** to retrieve, transmit over a network (**150**, **159**), and optionally confirm transmission of a data file **112**A. The transmission request **700** contains fields that specify retrieval, packaging, billing, transmission, and/or acknowledgment requirements of the transmission. For example, these fields may specify: (a) how the data file **112**A should be retrieved from a client **180** machine; (b) how the system **100** can bill the client **180** for work performed; (c) when the transmission should take place, and which destination clients (**160**, **170**) should receive the transmission; and/or (d) what acknowledgments the client **180** wants regarding the success and/or failure of the transmission.

[0099] The fields (a) which specify how the data file **112**A should be retrieved from a client **180** machine may include: a source address **710**, a retrieval options field **712**, a retrieval start time **714**, a retrieval interval field **716**, a maximum retrieval count field **718**, a packaging options field **720**, and/or an expected data file size **722** field.

[0100] The fields (b) which specify how the system **100** can bill the client **180** for the work performed may include: a billing account field **730**, an optional billing user field **732**, and/or an optional billing cost field **734**.

[0101] The fields (c) which specify when the transmission should take place, and who should receive the transmission may include: a transmission priority field **740**, a transmission release time field **742**, a transmission deadline field **744**, a retransmission interval field **746**, a retransmission count field **748**, a list of recipients **750**, and/or a bandwidth constraints field **752**.

[0102] The field (d) which specifies what acknowledgments the client **180** wants regarding the success and/or failure of the transmission is the acknowledgments field **760**.

[0103] In a preferred embodiment of the system **100**, the data file **112**A which is to be transmitted over the network (**150**, **159**) is not included in the transmission request **700**. Instead, the transmission request **700** contains information which instructs the content generator process **146**, described in FIG. **1**, how and when to retrieve the data file **112**A. The source address field **710** contains an address, e.g. a Uniform Resource Locator (URL), which indicates where the data file **112**A can be retrieved from. An optional retrieval options field **712** contains additional information such as a userid and password which is used in conjunction with the source address **710** to retrieve the data file **112**A over the network. A preferred embodiment of the system **100** includes scheduling information (**714**, **716**, **718**) which indicates when the data file **112**A should be retrieved. The retrieval start time field **714** indicates a time when a retrieval of the data file **112**A should be attempted. The retrieval interval field **716** indicates an interval, typically in seconds, after which a next retrieval should be attempted should a retrieval fail. The maximum retrieval count **718** field indicates the maximum number of retrieval attempts which should be made by the content generator process **146**. An expected data file size **722** field is also included in the transmission request **700** and contains a well known quantization of the size of the file **112**A to be transmitted. Typically, the field **722** contains a count of bytes.

[0104] There are many different ways to bring a data file **112**A from a client **180** to the mass storage **110**. Alternative embodiments of the system **100** may not include retrieval scheduling information (fields **714**, **716**, and **718**) in the transmission request **700** and may perform one and only one retrieval attempt at the time the transmission request **700** is received. Other embodiments perform a fixed number of

attempts. Further, the data file **112**A may not be available over a connected network (**150**, **159**) from the client **180** and need to be physically brought into the system **100**. The data file **112**A may arrive at a location accessible to the content generator process **146** on a CD-ROM, DVD disc, or VHS cassette tape. In these cases, alternative fields which include case-specific scheduling information (e.g. media type and a shippers tracking number) may be included in the transmission request **700**.

[0105] After a data file **112**A is stored in mass storage **110**, optional packaging transformations may be performed on the data file **112**A prior to its transmission. These transformations could include encryption, compression, or generation of forward error correction codes. The (optional) packaging options field **720** is used to indicate which, if any, transformations should be applied to the data file **1112**A.

[0106] In alternative embodiments, an additional field, the information content field **765**, is included in the transmission request **700**, in place of the fields pertaining to the retrieval of the data file **112**A (**710**, **712**, **714**, **716**, **718**). In this embodiment, the expected data file size **722** field may be omitted and the size of the data stored in the information content field **765** used in its place.

[0107] The client **180** indicates how the transmission should be charged through the billing account **730** and billing user **732** fields of the transmission request **700**. The billing account **730** field holds an account number/identifier such as a MasterCard or VISA credit card number or a previously negotiated identifier. The (optional) billing user **732** field contains a name or other identifier of the person placing the transmission request **700**.

[0108] The (optional) billing cost **734** field specifies a maximum cost that can be charged to the billing account **730** for the requested transmission. In a preferred embodiment, the billing cost **734** field is omitted and the cost of a transmission depends on other fields in the transmission request (expected data file size **722**, retransmission count **748**, transmission release date **750**, transmission deadline **744**, and selected acknowledgments **1356**). In alternative embodiments, the billing cost **734** field is used and can hold a dollar amount.

[0109] Several of the fields in the transmission request **700** hold details about when the transmission should take place, and who should receive the transmission. An optional transmission priority **740** field holds a keyword indicating a selected priority of the transmission. These keywords can include values such as "two day delivery", "acknowledged overnight delivery", and "freight". These values are used within the schedule architecture **800**, particularly in the acceptance process **139**, and the schedule process (**128**, **134**) to indicate a desired quality and speed of service. A "two day delivery" keyword would indicate that a file **112**A should be transmitted within 48 hours of receipt of the transmission request **700**. A "acknowledged overnight delivery" keyword would indicate that a file **112**A be transmitted before the next morning and that acknowledgments be returned by each recipient of the file **112**A. A "freight" keyword would indicate that the file **112**A be transmitted within a week of receipt of the transmission request **700**.

[0110] In a preferred embodiment, the transmission priority **740** field is omitted from the transmission request **700**. Instead of specifying a priority **740**, the transmission request **700** contains additional fields. The optional transmission release time **742** is the time after which the customer wants the file transmitted. The transmission deadline **744** is the time before which the file **112**A must to be transmitted. Note that these times can also be specified by a release time **744** and a transmission send window time, or a transmission deadline **744** and a transmission send window time.

[0111] The optional recipients **750** field designates the locations/people that are to be sent the file **112**A. Recipient information **750** is typically used when retransmissions **748** and/or acknowledgments **760** are used. In a broadcast situation, the recipients **750** need not be specified because everyone on the network will be sent the file.

[0112] The optional acknowledgments field **760** is used to indicate when an acknowledgment is required from one or more of the recipients. One type of acknowledgment **760** indicates that a recipient received the file **112**A, or parts of the file **112**A. Another type of acknowledgment, a negative acknowledgment, indicates that the recipient did not receive the file **112**A or did not receive parts of the file. For example, if a recipient expected a file **112**A at 10:00 PM and did not receive it, it would send a negative acknowledgment. If a recipient received a portion of a file **112**A and another portion of the file **112**A was not received (e.g. due to being timed out **615**, or due to network **150**, **159** error), the recipient would send an acknowledgment indicating partial reception. In some embodiments of the system, this would cause a retransmission **748** to take place.

[0113] The optional bandwidth constraints field **752** defines the bandwidth requirements for a particular file **112**A transmission. The bandwidth requirements can depend on the capabilities of the recipients, the quality of service that a subscriber paid for, and/or the physical requirements of the file **112**A (e.g. constant bitrate video requires a minimum bandwidth for real-time playback).

[0114] The optional retransmission fields (**746**, **748**) indicate that the client **180** requests retransmission of the file **112**A if not acknowledgment or negative acknowledgment is received by any of the recipients. Retransmissions (**746**, **748**) must conform to deadline **744** and bandwidth (**625**, **752**) availability requirements. The optional retransmission interval field **746** indicates an interval, typically in seconds, after which a next transmission (i.e. a retransmission) should be attempted. The retransmission count **748** field indicates the maximum number of retransmissions which should be performed.

[0115] The collection of fields **740**, **742**, **744**, **746**, **748**, **752**, and **722** is known as a transmission constraint **770**.

[0116] FIG. **7**A shows an example transmission request **700**A. In this non limiting example, a subscriber such as a product or service provider, e.g. an insurance company providing digitized training videos, located at the source address **710**, to its representatives (recipients **750**), requests that the videos **710** be sent out over a weekend in order to be used in a course in the following week (transmission deadline **744**). The company (billing account **730**) requests a quality of service which provides ten megabits of bandwidth (bandwidth constraint **752**), collection of acknowledgments **760** from the representatives, and a maximum of two retransmissions (retransmission count **748**). The video is 3.6 Gigabytes long (expected data file size **722**), approximately two hours of MPEG-2 compressed audio and video, and there are two groups of recipients: group B, the insurance agents, and group D, state regulators (see values in recipients field **750**).

[0117] If this transmission request **700**A is accepted into the system **100**, the video file **112**A will be retrieved from the source, e.g. FTP site, given in the source address **710**. A

maximum of three retrieval attempts (maximum retrieval count field **718**) will be made. The first retrieval attempt will begin at or after 21:00 on Thursday (retrieval start time **714**). Should the first retrieval attempt fail, a second retrieval will be attempted at or after 03:00 Friday, and possibly a third retrieval attempt at or after 09:00 Friday, per the six hour retrieval interval **716**. The source address **710** is public and no userid and password is specified in the retrieval options field **712**, which is empty. Once it is retrieved, the file **710** will be stored locally, in mass storage **110**, as a data file **112**A. The transmission request **700***a* indicates that no additional transformations (encryption, compression) should be performed after the data file **112**A retrieved (see packaging options field **720**).

[0118] In this transmission request **700**A, the transmission priority field **740** is empty and therefore the other transmission related fields (**742**, **744**, **746**, **748**) specify details about the scheduling of the file **112**A network transmission and retransmissions. The transmission release time **742** indicates that the retrieved file **112**A should be transmitted no earlier than 21:00 on Friday night and that all transmissions and retransmissions should conclude on or before 23:00 Friday (transmission deadline **744**). The transmissions should be broadcast at approximately 10 megabits per second (bandwidth constraints **752**). And two retransmissions **748** are requested after intervals of thirty minutes (retransmission interval **746**). A transmission of a 3.6 GB file at 10 Mbps will take eight minutes to complete. In an alternative embodiment, the transmission priority field **740** can be specified as described above and their will be no need to fill in fields **742**, **744**, **746**, **748**.

[0119] Charges for the retrieval, transmission, retransmissions, and acknowledgments the system **100** performs for this request **700**A will be billed to the Insurance Company (billing account **730**). The transmission request **700**A does not specify a billing user **732**, and does not place any restrictions on the amount to be billed **734**. Billing user field **732** could specify a specific individual at the insurance company that made the transmission request and/or be used to identify sub-accounts within the company, e.g. the education department. Billing cost field **734** is filled by the user to indicate the maximum amount the user is willing to pay for this transmission request **700**. If the maximum amount exceeds the cost of the transmission request **700** and the transmission is successful, no action is taken. However, if no retransmission count is specified, retransmissions will continue if no acknowledgment is received until the amount specified in the billing cost **734** is exhausted.

[0120] FIG. **8** is a block diagram of the architecture **800** of the scheduler (**128**, **134**) with an optional estimate transmissions process **1000** and other related functions. The architecture **800** is a system and method for scheduling digital information transmission and retransmission on a network during time slots.

[0121] Transmission requests **700** are received from a client **180** by the request receiver process **144**, described in FIG. **1** above. The transmission request **700** contains transmission constraints **770** such as transmission timing information as explained in the description of FIG. **7** (and in example in FIG. **7**A) and, in a preferred embodiment, pricing information. In some embodiments, the request receiver process **144** would notify the client **180** whether or not the transmission request **700** was accepted by the system **100**. For example, a notice would be sent to the client **180** if the billing cost amount **734** was too low for the service requested or if the network could not accommodate the transmission constraints (**740**, **742**, **744**, **746**, **748**, **752**, **722**), typically **770**.

[0122] The received transmission request **700** is passed to an acceptance process **139**, described in FIG. **14** below. The acceptance process **139** determines if it is possible to schedule a transmission of the information in the transmission request **700** in accordance to the received transmission constraints **770**. In an alternative embodiment, the acceptance process **139** is not used and a delivery status function **137** provides the acceptance function.

[0123] If the transmission request **700** for transmission is rejected by the acceptance process **139**, the request receiver process **144** is notified (and optionally notifies the client **180**) and a next request **700** is received. In a more preferred embodiment, the request receiver process **144** includes alternate transmission constraints **770** categorized by priority so that the acceptance process **139** can reject the transmission request **700** with one or more of the constraints **770** but accept the transmission request **700** with one of the other constraints **770**. In an alternative preferred embodiment, the acceptance process **139** would reject the transmission request **700** but would return through the request receiver process **144** to the client **180** alternate criteria (e.g. transmission time availability and pricing) which is used in a negotiating process between the system **100** and the client **180** to come to an acceptable transmission constraints **770** for the transmission request **700**. In another embodiment, the client **180** submits multiple transmission requests **700** with different transmission constraints **770**, probably starting with the most constrained transmission request **700** first. The client **180** continues submitting transmission requests **700** until the system **100** accepts one.

[0124] If a transmission request **700** is accepted, it is passed to a content generator process **146** as described in FIG. **1** above. The content generator **146** has two functions: a schedule retrieval function **841**; and a retrieval function **843**. The schedule retrieval function **841** determines if the file **112**A to be transmitted to satisfy the transmission request **700** is available, e.g. in the system mass storage **110**. If the file **112**A is available, the file is associated with the accepted transmission request **700** that contains the transmission constraints **770** for the file **112**A. If the file **112**A is unavailable, the schedule retrieval function **841** requests the retrieval function **843** to take an action to access the associated file **112**A. Such actions might include: notifying an operator to load a disk, tape, or CD; sending a request over the network, e.g. to the client **180** to transmit the file **112**A. The access of the file **112**A that is not available in the system memory **110** may occur hours or days after the request receiver process **144** receives the transmission request **700**. Preferably, the file **112**A will be brought into the mass storage/system memory **110** before the time specified in the transmission release time **742**. If the file **112**A is accessed late, corrective action will be taken by the feedback process **1300** as described in FIG. **13** below. Note that the files **112**A may be stored in the mass storage **110** and at different times be sent by different transmission requests **700**.

[0125] In a preferred embodiment, the retrieval function **843** access the files **112**A and ensures that they are in the memory **110**. Upon receiving a file **112**A into memory **110**, the retrieval function **843** (a) associates the file **112**A with the transmission request **700** and (b) stores the actual file **112**A size in the expected data file size field **722**. The association (a) is done because the location of the file **112**A in the mass

storage/system memory **110** may not be known until the file is received into memory **110**. The expected data file size field **722** is updated (b) upon receipt of the file **112**A because the exact size of the file **112**A may also not be known until the file **112**A is received and may be relevant to the pricing of the transmission.

[0126] The schedule retrieval **841** and retrieval **843** functions may be separate processes or performed as part of other processes in the system **800** (e.g. the request receiver process **144**).

[0127] The schedule process (**128**, **134**) contains an estimate transmissions process **1000** which receives an accepted transmission request **700** and its associated file **112**A. This process **1000**, modified by feedback process **1300** and an optional acknowledgment receiver process **135**, repeatedly creates and/or modifies delivery criteria records **914** in the delivery criteria list **114** to schedule the transmission of the file **112**A to meet the transmission constraints **770**. The estimate transmission process **1000** is described in more detail in FIG. **10**, below. The acknowledgment receiver process **135** is described in more detail in FIG. **13**, below. The delivery criteria records **914** of the delivery criteria list **114** are described in more detail in FIG. **9**, below.

[0128] In a preferred embodiment, entries in the transmission decision list **200** and file list **300** described above in the description of FIGS. **2** and **3**, are created by the schedule dispatch process **1100** and network use allocation process **1200**, see FIGS. **11** and **12** below, based on information in the scheduled delivery criteria list **114**. These lists (**200**, **300**) are used by the dispatching process **600** (**600**A, **600**B) to transmit the files **112**A and to generate the history log **400** and the network use criteria table **500** as described in FIGS. **4**, **5**, and **6** above. The history log **400** and network use criteria table **500** are used in the feedback process **1300**.

[0129] Hence, this architecture **800** is used in and further defines the system **100** where digital information (e.g. Files **112**A) are accepted for transmission (request receiver process **144**, acceptance process **139**), scheduled (estimate transmissions process **1000**, schedule dispatch process **1100**, network use allocation process **1200**), and transmitted (dispatch process **600**).

[0130] Note that the associated file **112**A may or may not be present in the memory **110** at the time process **1000** adds and/or modifies delivery criteria records **914** in the delivery criteria list **114**. Therefore, the system **800** allows reserving a transmission time with certain delivery criteria records **914** without having the actual file **112**A to be transmitted. In this way, the file **1112**A, meeting the transmission constraints **770**, can be under development up until the time the transmission request **700** requires transmission. This feature is useful in transmitting dynamic data, e.g. news or weather data, which is unavailable until just before the transmission time in the transmission constraints **770**. The feature is also useful in reserving a transmission time for data which is being developed in parts and transferred at various times and unified at a distant location. In this case, a daily time is reserved for transmission of files for information to be used, assembled, and examined in a collective work at another location.

[0131] For example, an on-line university may transmit a digitized lecture which is a portion of a digitized course one or two times a week at a certain time to its students. The availability of each lecture, as measured in terms of the time before transmission may vary. And the size of each lecture, as measured in terms of the file length of the compressed and/or digitized data file may vary. Some lectures may contain large image files, MPEG video, and lecture notes, while other lectures may just contain voice.

[0132] In one preferred embodiment, delivery criteria records **914** for files **112**A that are unable to be scheduled in conformance with their associated transmission constraints **770** are dropped. This could occur due to dynamic changes in the system **100**, e.g. delays, unforeseen increases in file sizes **722** which are delivered prior to the delivery criteria record **914**, or time-out situations **615**, or a transmission request **700** with a higher priority taking precedence of the system **100** resources. In a preferred embodiment, when delivery criteria records **914** are dropped, the schedule dispatch process **1100** sends a signal to a delivery status module **137**.

[0133] The delivery status module **137** first receives the dropped signal **882**. For delivery criteria records **914** that are dropped, the delivery status module **137** estimates **884** the impact of dropping the delivery criteria record **914**. This is done by determining to what extent other delivery criteria records **914** associated with the same file **112**A have been satisfied. For example, if the file **112**A of a dropped delivery criteria record **914** is scheduled for periodic retransmission and it is expected that these future retransmissions would satisfy the transmission constraints **770** for all or some of the recipients **750**, no action may be required at this time, but may be required later. However, if this time is the only time the file **112**A is transmitted and the file has a high priority, a dropped delivery criteria record **914** might have to be rescheduled at a later time, and this rescheduling may affect the current dispatch schedule.

[0134] Step **886** determines if the impact of dropping a delivery criteria record **914** exceeds a threshold. If the impact exceeds a threshold, corrective action **888** is taken.

[0135] For example, in one preferred embodiment dropping any delivery criteria record **914** exceeds the threshold **886** and the action taken **888** would be to alert an operator. In an alternative embodiment, the number of delivery criteria records **914** dropped is counted and if the count exceeds a count threshold, a program such as Tivoli is alerted to increase the network bandwidth allotted to the system **100**, when delivery criteria records **914** are being dropped due to network bandwidth problems. (Tivoli is a registered trademark of the IBM Corporation). In a further alternative embodiment, the system **800** determines why a delivery criteria record **914** was dropped and the corrective action **888** taken is to reschedule transmission with a new delivery criteria record **914** that permits the file **112**A to be transmitted.

[0136] In another alternate embodiment, the corrective action **888** taken is for the scheduler (**128**, **134**) to reschedule a transmit time after the digital information (portion of file **112**A) is rejected (dropped). The scheduler (**128**, **134**) may also contain a rejection queue and reclamation policy. In this alternate embodiment, as transmissions for files **112**A are dropped, they are placed on the rejection queue. A rejection policy within the estimate transmissions process **1000**, FIG. **10** below, and/or within the Schedule Dispatch process **1100**, FIG. **11** below, pulls entries from the rejection queue when as network bandwidth becomes available or when acknowledgments **135** are received and transmission constraints **770** are satisfied sooner than expected.

[0137] In another alternate embodiment, the corrective action **888** taken is to alert the acceptance process **139** of a network bandwidth shortage. Upon receiving the alert, the acceptance process **139** would refuse (or limit) the accep-

tance of transmission requests **700** with transmission constraints **770** that required transmission during a time window around the network bandwidth shortage time period. For example, in this alternate embodiment, the acceptance process **139** would refuse transmission requests **700** during days (peak hours, off-peak hours, . . .) where one or more preexisting delivery criteria records **914** were dropped. Or, the acceptance process **139** could refuse transmission request **700** higher than a given priority during time periods of known network congestion.

[0138] An alternative corrective action **888** is described in the acceptance process **139**, FIG. **14**, below.

[0139] FIG. **9** is a block diagram of one preferred storage filing system **110**. The storage system comprises any known storage means **110** which contains one or more filing system data structures **112**. These filing systems **112** contain files **112**A to be transmitted by the system **100**. The storage system **110** also comprises a database **113** which contains a delivery criteria list **114**. The delivery criteria list **114** has a plurality of records, typically **914**. Each delivery criteria record **914** has the following fields: a file list record **350** (see description, FIG. **3**, above); a file size **922**; a release time **924**; a deadline **926**; one or more optional recipients **928**; an acknowledgment designator **930**; an optional bandwidth **932**; and an optional retransmission designation **934**.

[0140] In a preferred embodiment, the delivery criteria records **914** of the delivery criteria list **114** are created and maintained by the estimate transmissions process **1000**, described in FIG. **10**, below. The process **1000** creates one or more delivery criteria records **914** for each transmission request **700** and each record **914** represents a transmission of the transmission request's associated data file **112**A. Delivery criteria records **914** may also represent a retransmission of some or all portions of an associated data file **112**A.

[0141] Each delivery criteria record **914** contains (or references) a file list record **350**. This file list record field **350** identifies the file **112**A which is to be transmitted to satisfy the delivery criteria record **914**.

[0142] The file size field **922** is any well known quantization of the size of the file (**350**, **112**A) to be transmitted. Typically the file size **922** is given in byte lengths. The release time field **924** is the time after which the file (**350**, **112**A) should be transmitted. The deadline field **926** is the time before which a transmission of the file (**350**, **112**A) should complete. Note that these times can also be specified by a release time **924** and a send window time, or a deadline **926** and a send window time.

[0143] The optional recipients **928** designate the location/people that are to be sent the file (**350**, **112**A). Recipient information **928** is typically used with retransmissions **934** and/or acknowledgments **930** are used. In a broadcast situation, the recipients need not be specified because everyone on the network will be sent the file (**350**, **112**A).

[0144] The optional acknowledgment field **930** is used to indicate when an acknowledgment is required from one or more of the recipients. One type of acknowledgment **930** indicates that a recipient received the file (**350**, **112***a*), or parts of the file (**350**, **112***a*). Another type of acknowledgment, a negative acknowledgment, indicates that the recipient did not receive the file (**350**, **112***a*) or did not receive parts of the file. For example, if a recipient expected a file (**350**, **112***a*) at 10:00 PM and did not receive it, it would send a negative acknowledgment. If a recipient received a portion of a file (**350**, **112***a*) and another portion of the file (**350**, **112***a*) was not received (e.g. due to being timed out **615**, or due to network **150**, **159** error), the recipient would send an acknowledgment indicating partial reception. In some embodiments of the system, this would cause a retransmission **934** to take place.

[0145] The optional bandwidth field **932** defines the bandwidth requirements for a particular file (**350**, **112***a*) transmission. The bandwidth requirements can depend on the capabilities of the recipients, the quality of service that a subscriber paid for, and/or the physical requirements of the file (**350**, **112***a*). (Constant bit rate video requires a minimum bandwidth for real-time playback).

[0146] The optional retransmission field **934** indicates that a client **180** requires retransmission of the file if no acknowledgment or negative acknowledgment is received by any of the recipients. Retransmissions **934** must conform to deadline (**615**, **926**) and bandwidth (**625**, **932**) availability requirements.

[0147] An example of a delivery criteria list **114** is shown in FIG. **9**A. This non limiting example is a continuation of the example given in FIG. **7**A. Referring to FIG. **7**A, a subscriber such as a product or service provider, e.g. an insurance company providing digitized training videos, located at the source address **710**, to its representatives (recipients **750**), requests that the videos **710** be sent out over a weekend in order to be used in a course in the following week (transmission deadline **744**). The company (billing account **730**) requests a quality of service which provides ten megabits of bandwidth (bandwidth constraint **752**), collection of acknowledgment **760** from teh representatives, and a maximum of two retransimssions (retransmission count **748**). The video is 3.6 Gigabytes long (expected data file size **722**), approximately two hours of MPEG-2 compressed audio and video, and there are two groups of recipients: group B, the insurance agents, and group D, state regulators (see values in recipients field **750**).

[0148] Now referring to FIG. **9**A. There are five delivery criteria records **914**(A, B, C, D, E) in the example delivery criteria list **114**. Delivery criteria records **914**A, **914**B, and **914**C are criteria for the transmission and retransmission of the transmission request shown in FIG. **7**A. Delivery criteria record **914**A requests a transmission of the 3.6 GB (size 922) file **112**A "training.mpg" (source file identifier **310** in file list record **350**) to be performed between 21:00 Friday (release time **924**) and 23:00 Friday (deadline **926**) to the recipient groups B and D (recipients **928**) with acknowledgments **930** at a bandwidth of 10 Mbps (bandwidth **932**). Delivery criteria record **914**A also indicates that two retransmissions **934** may follow. Delivery criteria records **914**B and **914**C are identical to delivery criteria record **914**A except that they have different release times **924** (21:30 Friday and 23:00 Friday, respectively) and different retransmissions fields **934** (containing values of one and zero, respectively).

[0149] Delivery criteria records **914**D and **914**E are the criteria records for other transmission requests **700**. Delivery criteria record **914**D requests a transmission of the 375 MB (size **922**) file **112**A "rulesUpdate.zip" (source file identifier **310** in file list record **350**) to be performed between 21:30 Friday (release time **924**) and 22:00 Friday (deadline **926**) to the recipient groups A and B (recipients **928**) with no acknowledgments **930** or retransmissions **934** at a bandwidth of 5 Mbps (bandwidth **932**). Delivery criteria record **914**E requests a transmission of the 750 MB (size **922**) file **112**A "catalog.zip" (source file identifier **310** in file list record **350**) to be performed between 22:00 Friday (release time **924**) and 22:30 Friday (deadline **926**) to recipient group C (recipients

928) with no acknowledgments **930** or retransmissions **934** at a bandwidth of 10 Mbps (bandwidth **932**).

[0150] In this example, delivery criteria **914**A, **914**B, and **914**C request three transmissions of their associated file **112**A. The three transmissions are to be scheduled with release times **924** that are thirty minutes apart. Thirty minutes being the retransmission interval **746** of sample transmission request **700**A.

[0151] Note that delivery criteria **914**B and **914**D have the same release time **924** value.

[0152] In this example, the system **100** sent the entire package during an available network slot on Friday night **924**. However, due to a cut cable network outage, the regulators (recipients **928** group D) did not receive the package and did not send an acknowledgment. Also, because of client limitations, the agents (recipients **928** group B) only received half of the package. Since the agents only acknowledged receipt of half of the package, and no acknowledgment was received from the regulators, the entire package was retransmitted to the regulators and the missing half was retransmitted to the agents. These functions were performed by the scheduling process (**128**, **134**). Criteria for different transmission requests **700** are given in each of the records (typically **914**) of the delivery criteria list **114** containing the delivery criteria records **914**.

[0153] FIG. **10** is a flow chart of an estimate transmissions process **1000**. This process **1000** receives accepted transmission requests **700** and creates records **914** in the delivery criteria list **114** so that the associated files **112**A will be transmitted by the system **100**. The schedule process (**128**, **134**) executes the estimate transmissions process **1000** each time a new transmission request **700** is accepted **841** into the system (**128**, **134**), and each time information is generated (e.g. an exact file **112**A size is determined, a prior transmission of the file **112**A completes **1300**, and acknowledgments **135** are received from clients **160**, **170**) regarding the transmission request **700**. When executed, the estimate transmissions process **1000** will modify the delivery criteria list **114** so that the file **112**A will be transmitted (and/or retransmitted) over the network (**150**, **159**).

[0154] The estimate transmissions process **1000** begins **1020** by determining a current release time which is the earliest time a transmission of the file **112**A can take place. The current release time **1020** is the greater of the transmission release date **742** specified in the accepted transmission request **700** and the current system time **125**. The process **1000** then iterates **1030** over the transmissions which need to be scheduled making a delivery criteria record **914** in the delivery criteria list **114** for each required transmission. When the process **1000** is first called with a newly accepted transmission request **700**, the process **1000** will iterate once to create a delivery criteria record **914** for an initial transmission of the file **112**A, and then will continue to iterate, once per requested retransmission **748**, to create delivery criteria records **914** for retransmissions of the file **112**A. When the process **1000** is called after one or more transmissions and/or retransmissions have taken place, the process **1000** iterates **1030** to modify the remaining delivery criteria records **914**, e.g. to reset the release time (e.g. if bandwidth is freed up), and/or to adjust the size (e.g. if part of the transmission was sent and acknowledged).

[0155] The process **1000** creates and selects **1040** a delivery criteria record **914** in the delivery criteria list **114** for each transmission which is to take place. If the process **1000** has already created a delivery criteria record **914** for this transmission during a prior execution, the previously created delivery criteria record **914** is simply selected in the delivery criterialist **114** and not recreated. This is to avoid having duplicate records **914** in the delivery criteria list **114**.

[0156] When the process **1000** creates **1040** a delivery criteria record **914**, it sets the fields of the new delivery criteria record **914** as follows: the size **922** field is set to the size of the file **112**A; the deadline field **926** is set to the transmission deadline **744** of the transmission request **700**; the recipients field **928** is set to the recipients **750** field of the transmission request **700**; the acknowledgments field **930** is set to the acknowledgments field **760** of the transmission request **700**; the bandwidth field **932** is set to the bandwidth constraints field **752** of the transmission request **700**; and the optional retransmissions field **934** is set to the retransmission count field **748** of the transmission request **700**. Further, the process **1000** sets the fields of the file list record **350** contained in the delivery criteria record **914** as follows: the source file identifier **310** is set to the location of the file **112**A in mass storage **110**; the cursor field **315** is set to indicate the start of the file (typically set to 0); and the destination address **320** field of the file list record **350** within the delivery criteria record **914** is set to a network address for the listed recipients **750**.

[0157] In both cases, i.e. for new and existing delivery criteria records **914**, the process **1000** continues to step **1050** where the release time **924** field of the selected delivery criteria record **914** is set to hold the current release time **1020** value. Step **1050** also sets the recipients field **928** of new and existing delivery criteria records **914**. In a preferred embodiment, the recipients field **928** is set to the groups of recipients **750** who have not yet acknowledged receipt of the entire file **112**A. In alternate embodiments, the recipients field **928** is set to the group of recipients listed in the recipients field **750** in the transmission request **700**.

[0158] Through these two steps (**1040**, **1050**), the process **1000** has created/modified a delivery criteria record **914** that will cause a transmission/retransmission of the file **112**A to be scheduled by the schedule dispatch process **1100**, described in FIG. **11** below, and dispatched by the dispatching process **600**.

[0159] The process **1000** continues to determine **1060** the parameters for a next retransmission of the file **112**A. There are many different ways that values can be selected for the fields (e.g. the release time **924**, and the deadline **926**) of the delivery criteria record **914** for a next retransmission. Steps **1070**A, **1070**B, and **1070**C show three distinct ways of determining a next release time **924** for a next retransmission. Steps **1070** A, B, and C are different preferred embodiments of the invention. In some embodiments, these steps can be user selected. One step would be selected over another by balancing ease of scheduling with network bandwidth use and expected data loss.

[0160] Step **1070**A maintains a constant release time **1020** throughout the delivery criteria records **914**. Step **1070**B increments the current release time **1020** by the retransmission interval **746** value of the transmission request. And step **1070**C allots a portion of the time between the initial release time set in step **1020** and the deadline to each transmission/retransmission. This is easier to schedule but could use more network bandwidth.

[0161] Choosing to perform step **1070**A makes all delivery criteria records **914** for the transmission request **700** have the same release time **924**. This means that the schedule dispatch

process **1100** may schedule the retransmissions to take place simultaneously. And, because each delivery criteria record **914** has the largest possible window of time between its release time **924** and deadline **926** this step **1070**A has the greatest likelihood of creating feasible schedules.

[0162] Choosing to perform step **1070**B causes the release times **924** of the delivery criteria records **914** to be staggered throughout the window between the transmission release date **742** and the transmission deadline **744**. Each successive delivery criteria record **914** has a release time **924** which is offset from the previous delivery criteria's release time **924** by the retransmission interval **746**. By staggering the release times **924**, transmissions of a file **112**A are more likely to not be broadcast over the network **150**, **159** simultaneously. And, by basing the release time **1020** logic on the value of a field (i.e. the retransmission interval **746**), the characteristics of the system **100** can be changed by altering the retransmission interval **746** value. Step **1070**B potentially uses less bandwidth than step **1070**A and gives flexibility in scheduling the retransmissions.

[0163] Choosing to perform step **1070**C causes the release times **924** of the delivery criteria records **914** to be evenly distributed between the window of the transmission release date **742** and the transmission deadline **744**. This further lessens the likelihood of simultaneous transmissions and tends to cause the transmissions to be dispatched distributed throughout the window. However, as the release time **924** of a delivery criteria record **914** nears the deadline **926** of the delivery criteria record **914**, the chances that the delivery criteria record **914** may not be able to be scheduled by the dispatch schedule process **1100** increase. Step **1070**C potentially uses less network bandwidth than step **1070**A and **1070**B but does not allow flexibility in scheduling the retransmissions.

[0164] Step **1070**B is performed in a preferred embodiment. Alternative embodiments may perform either steps **1070**A or **1070**C. Delivery criteria records **914**A, **914**B, and **914**C in FIG. **9**A, above, show the result of executing process **1000** with step **1070**B against transmission request **700**A, described in FIG. **7**A.

[0165] Note that because the deadline **926** of the delivery criteria record **914** is kept constant by each of the steps (**1070**A, **1070**B, **1070**C), the steps all generate delivery criteria records **914** which may result in simultaneous transmissions. Further, all transmissions may be scheduled at the latest time possible by the dispatch scheduler. Alternative embodiments may modify the deadline **926** of delivery criteria record **914** in order to guarantee that a transmission is completely dispatched well before its transmission deadline **744** and in time for acknowledgments to be received and processed by the acknowledgment receiver process **135**.

[0166] In another alternative embodiment, the estimate transmissions process **1000** may only generate a delivery criteria record **914** for one retransmission (rather than all retransmission count **748** retransmissions). This would be done by iterating once in step **1030** instead of iterating over all transmissions. In this alternative embodiment, simultaneous transmissions of the same file **112**A would not occur because only one delivery criteria record **914** for the transmission request **700** would be in the database at any one time. As the feedback process **1300** indicated that the transmissions were completed, and as acknowledgments were received by process **135**, successive delivery criteria record **914** could be created for any necessary retransmissions.

[0167] Once the parameters are determined for the next delivery criteria record **914**, the process proceeds to step **1080** where a next iteration of step **1030** takes place. Once all transmissions have been iterated **1030** over, the process ends **1090**.

[0168] The scheduling processes **1100**, FIG. **11**, and **1200**, FIG. **12**, novelty use Earliest Deadline First (EDF) scheduling techniques while accounting for network bandwidth limitations to determine if files **112**A can be dispatched **600** within the required time period subject to networking and transmission constraints.

[0169] FIG. **11** is a flow chart of a scheduler process **1100** that converts information in the delivery criteria list **114** into commands in the transmission decision list **200** that are used by the dispatcher process **600** (**600**A, **600**B). In addition, the scheduler process **1100** determines whether or not the delivery criteria records **914** in the delivery criteria list **114** can be satisfied by the available system **100** resources to transmit files **112**A over the satellite **150** and/or over the network **159**.

[0170] The process **1100** begins, step **1110**, by accessing information in the network use criteria table **500**. In a preferred embodiment, the information in this table **500** is duplicated **1110**.

[0171] The process **1100** then iterates **1115** over the delivery criteria list **114**. In a preferred embodiment, step **1115** sorts the delivery criteria records **914** in the delivery criteria list **114** by deadline **926**, in increasing order, earliest deadline first.

[0172] Step **1120** determines a record, e.g. by setting a pointer, in the transmission decision list **200**, and saves a prior state of the network use criteria table **500**.

[0173] Step **1125** initializes a quantity variable to the cursor **315** identified in the file list record **350** of the delivery criteria record **914** selected by the iteration step **1115**.

[0174] Step **1130** performs another iteration while the quantity variable set in step **1125** is less than the size **922** of the selected delivery criteria record **914**. While the condition in step **1130** exists, step **1200** is performed which attempts to tentatively reserve use of the network for the selected delivery criteria record **914** by placing time stamp **505** and defined network use **510** information in the network use criteria table **500**, for the respective delivery criteria record **914**. See the description of the FIG. **12**, below.

[0175] Step **1140** determines whether or not process **1200** was able to tentatively reserve the network use, by examining the return code (**1215**, **1245**, **1280** below).

[0176] If the return code indicates that the attempted reservation failed (**1215**, **1245**), step **1170** rejects the selected delivery criteria record **914**, and optionally sends a drop signal to the delivery status **137**. Then step **1175** changes the transmission decision list **200** to remove all the entries **250** associated with the selected record **914**. In a preferred embodiment, the removed entries **250** are all those entered after the pointer set in step **1120**. Further, step **1175** changes the network use criteria table **500** to restore the network use criteria table **500** to the state prior to the performance of step **1120**.

[0177] If step **1140** determines that the network use was reserved (**1280**) in process **1200**, step **1150** returns back to step **1130** where a next reservation will be attempted for a next portion of the delivery criteria record **914**. If the quantity variable **1125** is equal to the file size **922**, step **1155** is performed and finally commits the changes in the transmission decision list **200** and the network use criteria table **500**. In a

preferred embodiment, this allows the pointer in table **1120** to be moved and the prior state information in table **500** to be overwritten. In a preferred embodiment, these functions (transactions, rollbacks, commits) are performed by standard database techniques.

[0178] After step **1155** or step **1175** has completed, step **1180** determines if there is another delivery criteria record **914** to iterate over. If there is, the process **1100** returns to step **1115**. If not, the scheduler process **1100** ends.

[0179] FIG. **12** is a flow chart of a novel network use allocation process **1200** which tentatively reserves network use in the network use criteria table **500** so that some or all of a transmission for a selected delivery criteria record **914** can be performed. Further, the network use allocation process **1200** creates transmission criteria records **250** which instruct the dispatching process **600** when to begin the selected delivery criteria record **914** transmission.

[0180] This process **1200** is executed numerous times during execution of process **1100**, FIG. **11** above. While process **1200** is executing, it accesses the delivery criteria record **914** selected in step **1115**, process **1100**. Process **1200** accesses and modifies the network use criteria table (**500**, **1110**) which is duplicated **1110** at the start of process **1100**, possibly adding new network use criteria records **550** to the table **1110**. Process **1200** modifies the transmission decision list **200** by creating new transmission criteria **250**. And, process **1200** also modifies the value of the quantity variable **1130** maintained by process **1100**.

[0181] The process **1200** begins **1205**, by finding a network use criteria record **550** in the network use criteria table (**500**, **1110**) that meets the following constraints: **1205***a* it has a time stamp **505** which is greater than or equal to the release time **924** but less than the deadline **926** of the selected delivery criteria (**914**, **1115**); and, **1205***b*, has ample remaining bandwidth **530** to support the bandwidth requirements **932** of the selected delivery criteria (**914**, **1115**). In a preferred embodiment, this search **1205** is performed via an iteration of the network use criteria table (**500**, **1110**), ordered by time stamp **505**. The time stamp constraint, **1205***a*, causes step **1205** to search for a network use criteria record **550** which indicates the availability of network use during the time window of the delivery criteria (**914**, **1115**). Any network use criteria records **550** which define network use for periods before the release time **924** or after the deadline **926** will be ignored by the constraint **1205***a*.

[0182] The bandwidth check constraint, **1205***b*, causes step **1205** to search for network use criteria records **550** which indicate that there is enough bandwidth available in the network to transmit some or all of the file **112**A of the selected delivery criteria (**914**, **1115**). In a preferred embodiment, the bandwidth check **1205***b* consists of comparing the bandwidth requirements **932** against the remaining bandwidth **530** of the network use criteria record **550**. When the bandwidth requirements **932** specify a bandwidth which is less than or equal to the remaining bandwidth **530**, the bandwidth check constraint **1205***b* is considered met. When the bandwidth requirements **932** specify a bandwidth which is greater than the remaining bandwidth **530**, the bandwidth check constraint **1205***b* rejects the network use criteria record **550** as a candidate for step **1205**.

[0183] In a preferred embodiment step **1205** will select the network use criteria record **550** with the earliest time stamp **505** that meets the constraints (**1205***a*, **1205***b*).

[0184] If no network criteria records **550** exist which meet the constraints (**1205***a*, **1205***b*), the process **1200** sets a failure indicator **1215** and returns. This will cause execution of process **1100** to move to step **1170** where the selected delivery criteria (**914**, **1115**) will be dropped from the transmission schedule.

[0185] If a network use criteria record **550** is found, step **1210**, execution of process **1200** continues to (optional) step **1220**. In step **1220**, process **1200** performs a second search of the network use criteria table (**500**, **1110**). The process **1200** searches to find the set of zero or more additional network use criteria records **550** which satisfy the constraints (**1205***a*, **1205***b*) and which are contiguous in time. That is, the process **1200** finds each record **550**(*a*) in the network use criteria table (**500**, **1110**) which satisfies constraints (**1205***a*, **1205***b*) and where there does not exist a second record **550**(*b*) having a time stamp **505**(*b*) with a value between the time stamp **505** of the found record **1205** and the time stamp **505**(*a*) that does not satisfy the constraints (**1205***a*, **1205***b*).

[0186] By performing these searches (**1205**, optionally **1220**), the process **1200**, locates a range of time where there is enough network use available to transmit some or all of the file **112**A for the selected delivery criteria (**914**, **1115**).

[0187] In a preferred embodiment, network use criteria records **550** can be iterated over in the network use criteria table **500**, by order of increasing time stamp **505**. This means that the searches (**1205**, **1220**) can be performed easily and in linear time.

[0188] After finding contiguous network use criteria records **550**, execution continues to step **1225** where the process **1200** begins to reserve bandwidth for a transmission. The process **1200** portions the first found **1205** network use criteria record **550** into two new network use criteria records **550**, **1225***a* and **1225***b*. The first network use criteria record **1225***a* holds bandwidth/network use allocated for a window of time after the time stamp **505** of the network use criteria record (**550**, **1205**) but before the release time **924** of the selected delivery criteria record (**914**, **1115**). The second network use criteria record **1225***b* holds the remainder of the bandwidth/network use from the first found **1205** network use criteria record **550**.

[0189] The fields of network use criteria record **1225***a* are set as follows: values for the time stamp **505** and (optional) network identifier **520** fields are copied from the respective fields of the first found **1205** network use criteria record **550**. And the aggregate **515** and defined network use **510** fields are set to a proportion of the aggregate **515** and defined network use **510** fields, respectively, of network use criteria record **1205** equal to the proportion of the window between the release time **924** and the time stamp **505**, compared to the network use window **525**.

[0190] The fields of network use criteria record **1225***b* are set as follows: the value of the (optional) network identifier **520** field is copied from first found **1205** network use criteria record **550**. The time stamp **505** field is set to the release time **924** of the selected delivery criteria (**914**, **1115**). And the aggregate **515** and defined network use **510** fields are set to the remaining proportion of the aggregate **515** and defined network use **510** fields, respectively, of network use criteria record **1205** equal to the proportion of the window between the release time **924** and end of the network use window **525**, compared to the network use window **525**.

[0191] After creating network use criteria record **1225***b*, the process **1200** removes network criteria record **1205** from the

network criteria table (**500**, **1110**). And the process **1200** sets the first found network use criteria record **1205** to be network use criteria record **1225***b*.

[0192] For example, suppose that the release time **924** of the selected delivery criteria (**914**, **1115**) occurs five minutes after the time stamp **505** of network use criteria record **1205**. And suppose that the network use window **525** field of the network use criteria record **1205** contains a value of twenty minutes. Further, suppose that network use criteria record **1205** defines 100 units of network use **505** and has an aggregate amount of network use **510** of 60 units. Then, the release time **924** occurs ¼ of time into the network use window **525**. Thus, new network use criteria record **1225***a* would have a defined network use of 25 units and an aggregate amount of network use **515** of 15 units. And new network use criteria record **1225***b* would have a defined network use of 75 units and an aggregate amount of network use **515** of 45 units.

[0193] In cases where the time stamp **505** of network use criteria record **1205** is greater than or equal to the release time **924** of the selected delivery criteria (**914**, **1115**), network use criteria records **1225***a* and **1225***b* are not created by step **1225**.

[0194] By performing step **1225**, the process **1200** has now found a range of network use criteria records (the record **550** found in step **1205** and possibly replaced by new record **1225***b*, and those records **550** found in step **1220**) all of which have time stamps **505** which are equal to or greater than the release time **924** of the selected delivery criteria (**914**, **1115**).

[0195] Process **1200** now iterates **1230** over the found network use criteria records **550**, selecting each network use criteria record **550** ordered by time stamp **505**.

[0196] During each iteration **1230**, the process **1200** computes, step **1235**, a portion quantity **1235***a* of data which needs to be transmitted to satisfy the selected delivery criteria (**914**, **1115**). This portion quantity **1235***a* is equal to the value in the size **922** field of the selected delivery criteria record (**914**, **1115**) less the amount in the quantity variable **1130** of process **1100**. The process **1200** then determines a computed bandwidth rate **1235***b* suitable for the selected network criteria **550** and divides the portion quantity **1235***a* by the computed bandwidth rate **1235***b* to compute a duration value **1235***c*.

[0197] Step **1235** is a time to transmit process which determines the time to transmit a portion of a file **112**A within the constraints of the delivery criteria record **914**, transmission criteria **770**, and available network use **550**. In alternative embodiments, these transmission criteria **770** can further include the time of day and/or size of network buffers (**124**A, **124**B).

[0198] In a preferred embodiment, the computed bandwidth rate **1235***b* is set to the bandwidth **932** specified in the selected delivery criteria record (**914**, **1115**). In alternate embodiments, the computed bandwidth rate **1235***b* may vary if the bandwidth **932** specifies a range of allowable bandwidth values. In these alternate embodiments, the computed bandwidth rate **1235***b* may be set to a preferred bandwidth value which is specified **932** in the selected delivery criteria record (**914**, **1115**) and which there is space for (remaining bandwidth **530**) in the selected network use criteria record **1230**.

[0199] If the computed duration value **1235***c* is greater than the window between the time stamp **505** of the selected network use record **1230** and the next network use record **550**, step **1235** adjusts the computed duration value **1235***c* to be equal to the window. And step **1235** adjusts the portion quantity **1235***a* to be equal to the amount of data which can be written in that window, e.g. the computed bandwidth rate **1235***b* multiplied by the new computed duration value **1235***c*.

[0200] The process **1200**, step **1240**, then compares the computed duration value **1235***c* against the deadline **926** in the selected delivery criteria record (**914**, **1115**). When the value of the time stamp **505** of the selected network use criteria record **1230** plus the computed duration value **1235***c* is greater than the deadline **926**, execution of the process **1200** moves to step **1245** where the process sets a failure indicator, ends its execution, and returns to process **1100**. In this case, the process **1200**, step **1245**, has determined that there is not enough time and bandwidth available between the time stamp **505** and the deadline **926** to complete the transmission of the file **112**A and, hence, a failure code is returned.

[0201] When the process **1200** determines that there is enough time and bandwidth to transmit a portion **1235***a* of the file **112**A before the deadline, execution moves to step **1250**. The process, step **1250**, compares the computed duration value **1235***c* to the network use window **525**. If the computed duration value **1235***c* holds a time interval smaller than the network use window **525**, step **1255** portions the selected network use criteria record **1230** into two new network use criteria records **1255***a* and **1255***b*.

[0202] New network use criteria record **1255***a* represents the network use during the time period starting at the time stamp **505** of network use criteria record **1230** and extending to the time interval of the computed duration **1235***c*. Network use criteria record **1255***b* represents the network use for the remainder of the time at and past the duration **1235***c* up to the network use window **525**.

[0203] The fields of network use criteria record **1255***a* are set as follows: values for the time stamp **505** and (optional) network identified **520** fields are copied from the respective fields of the selected network use criteria record **1230**. And the aggregate amount of network use **515** and defined network use **510** fields are set to a proportion of the aggregate amount of network use **515** and defined network use **510** fields, respectively, of network use criteria record **1230** equal to the proportion of the window between the duration **1235***c* and the network use window **525** of the selected network use criteria record **1230**.

[0204] The fields of network use criteria record **1255***b* are set as follows: the value of the (optional) network identifier **520** field is copied from first found **1205** network use criteria record **550**. The time stamp **505** field is set to the value of the time stamp **505** of the selected network use criteria record **1230** plus the duration **1235***c*. And the aggregate amount of network use **515** and defined network use **510** fields are set to the remaining proportion of the aggregate amount of network use **515** and defined network use **510** fields, respectively, of network use criteria record **1230** equal to the proportion of the time between the duration **1235***c* and the network use window **525**.

[0205] After creating network use criteria records **1255***a* and **1255***b*, the process **1200** removes network criteria record **1230** from the network criteria table (**500**, **1110**). And the process **1200** sets the selected network use criteria record **1230** to be network use criteria record **1255***a*.

[0206] Execution of the process **1200** then continues to step **1260**. Step **1260** will also be executed (and step **1255** bypassed) when step **1250** finds that the computed duration **1235***c* is equal to the network use window **525**.

[0207] Step **1260** creates a new transmission criteria **250** record for the transmission criteria table **200**. This transmis-

sion criteria **250** record instructs the dispatching process **600** to send a portion of the file **112**A for the selected delivery criteria (**914**, **1115**). The fields of the new transmission criteria **250** are set as follows: the index **205** is set to the index **305** of the file list record **350** in the selected delivery criteria record **914**; the release time **210** is set to the time stamp **505** of the selected network use criteria record **1230**; the quantity completion measure **235** is initialized (set to zero in a preferred embodiment); and the status code **240** is set to a "Pending" value.

[0208] In a preferred embodiment, step **1260** sets the burst size **225** and burst rate **230** fields to values for the computed bandwidth rate **1235***b* determined in step **1235**. The portion quantity field **215** is set to the computed portion quantity **1235***a*, and the duration field **220** is set to the computed duration **1235***c*. In alternate embodiments, the duration field **220** may be left unspecified, set to the value of the deadline **926** in the selected delivery criteria record (**914**, **1115**), or set to the value of the time stamp **505** in the next network use criteria record **550**.

[0209] Step **1260** has now created a new transmission criteria **250** record requesting that the dispatching process **600** transmit a portion of the file **112**A for the selected delivery criteria record (**914**, **1115**). Execution of process **1200** moves to step **1265** where **1265***a* the value of the computed portion quantity **1235***a* is added to value stored in the aggregate amount of network use field **515** for the selected network use criteria record **1230**. This records that network use has been reserved for the new transmission criteria **250** record. Process **1200** further **1265***b* adds the computed portion quantity **1235***a* to the quantity variable **1125** of process **1100**. Thus quantity variable **1125** is updated to hold the amount of data which has been scheduled for the currently selected delivery criteria (**914**, **1115**).

[0210] Step **1270** compares the quantity variable **1125** to the value of the size **922** field in the selected delivery criteria record (**914**, **1115**). If the quantity **1125** is not equal to the size **922**, more transmission criteria **250** records need to be created to satisfy the delivery criteria (**914**, **1115**). The process **1200** continues execution to step **1275** where, if there are more found network use criteria records **1230**, execution branches back to step **1230**.

[0211] When the quantity **1125** is equal to the size **922** (step **1256**), or when there are no more network use criteria records **1230** to iterate over (as determined by step **1275**), execution continues to step **1280** where the process **1200** sets a success indicator value and execution of process **1200** ends.

[0212] Note that the constraints (**1205***a*, **1205***b*) chosen for steps **1205** and **1220** determine the range of time during which a portion of a delivery criteria record **914** may be transmitted. Constraints **1205***a*, **1205***b* have been chosen to match the characteristics of the dispatching process (**600**A, **600**B) used in a preferred embodiment of this invention.

[0213] Alternative embodiments may use alternate processes, such as the Fazzt Digital Delivery System by KenCast, Inc. to perform the function of the dispatching process (**600**A, **600**B). New constraints in addition to, or in replacement for, constraints **1205***a* and **1205***b* may be added to the network use allocation process **1200**. For instance, if the alternate dispatching process **600** has a limitation on the number of simultaneous portions of files **112**A which may be transmitted at any given time, a constraint **1205***c* may be introduced to process **1200** which enforces this limit. A constraint **1205***c* may check that no more than four transmission criteria records **250** exist with release times **210** and durations **220** that overlap the network use window of a candidate (**1205**, **1220**) network use criteria record **550**. This alternate constraint **1205***c* would cause the network use allocation process **1200** to not schedule any more than overlapping simultaneous transmission criteria records **250**.

[0214] Another alternate constraint **1205***d* could be put in place to check that there was enough remaining network bandwidth in contiguous network use criteria records **500** so that it was possible to schedule the file **112**A for transmission as one portion.

[0215] Further, an alternate constraint **1205***e* could be put in place to limit the cumulative bandwidth delivered to a destination or destination group during a time period. Alternate constraint **1205***e* could check, for example that no more than a cumulative 10 Mbps was transmitted for a destination, regardless of the number of simultaneous transmissions delivered to the destination.

[0216] Process **1100** iterates over the delivery criteria list **114**, step **1115**, ordered by deadline **926**, and the delivery criteria record **914** which have the earliest deadlines **926** are scheduled first. Process **1100** and **1200** use the network use criteria table **500** to schedule based on bandwidth as well as time. Constraint **1205***b* of process **1200** allows multiple transmissions of portions of files **112**A to be scheduled simultaneously during the same time period therefore allowing overlapping and simultaneous scheduling. Step **1265***a* of process **1200** works with constraint **1205***b* to keep track of the bandwidth consumed by simultaneously scheduled transmissions so that the cumulative bandwidth scheduled during a time period is not greater than the available bandwidth for the time period.

[0217] Further, by allowing multiple network use criteria records **550** to exist, each with a distinct network use window **525**, processes **1100** and **1200** can create schedules which are designed for networks (**150**, **159**) with non constant bandwidth availability. As discussed in FIG. **5** above, differing portions of bandwidth may be available to a network during different times of day. For instance, 45 Mbps of network bandwidth may be available during off-peak hours but only 15 Mbps available during peak time.

[0218] A preferred embodiment of this invention creates a transmission decision list **200** using processes **1100** and **1200**. Alternate embodiments may use other scheduling algorithms such as more complicated EDF algorithms, e.g. the Robust Earliest Deadline (RED) algorithm, or algorithms which schedule by other means, e.g. Rate Monotonic (RM) algorithms. These algorithms may be amended to contain constraints similar to **1205***b* to check for available bandwidth, and to record aggregate amounts of network use as done in step **1265***a*. EDF aigorithmns are discussed in the book *Deadline Scheduling For Real-Time Systems, EDF and Related Algorithms* by John A Stankovic, Marco Spuri, Krithi Ramamritham, Giorgio C. Buttazzo Copyright 1998 by Kluwer Academic Publishers, ISBN 0-7923-8269-2, which is herein incorporated by reference in its entirety.

[0219] FIG. **13** is a flow chart of an optional feedback process **1300** which examines entries in the file transmission history log **400** and adjusts related transmission requests **700** accordingly.

[0220] The process **1300** begins, step **1310**, by iterating **1320** over the entries in the history log **400**. The history log **400** is populated by the dispatching process **600** (**600**A, **600**B) whenever a portion of a file **112**A is transmitted over

the network (**150**, **159**). In a preferred embodiment, the process **1300** iterates over history records **450** which have been added to the history log **400** after a previous execution of process **1300**. By doing this, history records **450** are not examined twice. The process **1300** can detect newly added history records **450** by examining the value in the completion time stamp **420** field.

[0221] Step **1325** locates the transmission request **700** associated with the history record **450**. The transmission request **700** can be found through the index **405** field of the history record **450**. The index **405** field identifies the file list record **350** and thus identifies the file **112**A which has an association with the transmission request **700**. Through similar steps of following indirection, the process **1300** can locate the delivery criteria record **914** which contains the file list record **350** associated with the history log **450**.

[0222] The process **1300** then, step **1330**, examines the status code **415** field of each history record **450** selected in step **1320**. The status code **415** field contains information regarding an attempted transmission of a portion of a file **112**A over the network (**150**, **159**). In a preferred embodiment, the status code **415** is checked to see if it contains one of two values. When the status code **415** contains a "File not found" indicator, the dispatch process **600** attempted to make a transmission but found that the file **112**A did not exist in the memory/mass storage **110**. In this case, the process moves to step **1340**. When the status code **415** contains a "Success" indicator, the dispatch process **600** successfully transmitted a portion of a file **112**A over the network (**150**, **159**). In this case, the process moves to step **1370**. In alternate embodiments, the status code **415** is checked to see if it contains additional values such as a "Preempted due to network error" or "Preempted due to disk error" and appropriate steps are performed for each of these indicators.

[0223] When a file **112**A was not found by the dispatch process **600**, execution of the process **1300** moves to step **1340**. Step **1340** increases the transmission release time **742** of the found transmission request (**700**, **1325**). In a preferred embodiment, the transmission release time **742** is increased by a fixed value, e.g. an hour. In alternate embodiments, the transmission release time **742** may be increased by a value related to the expected data file size **722**.

[0224] The transmission release time **742** is increased because the data for the file **112**A has not yet been completely retrieved from the client **180** by retrieval function **843**. Increasing the transmission release time **742** allows the retrieval function **843** to have more of an opportunity to receive the data file **112**A.

[0225] Note that as the transmission release time **742** is increased and moves closer to the transmission deadline **744**, it is more likely that a schedule cannot be created by the schedule process **800** which will satisfy the transmission criteria **770** with available network use **500**. By increasing the transmission release time **742**, the feedback process **1300** may cause the transmission request **700** to be dropped **882** by the schedule dispatch process **1100**. In an extreme case, the transmission release time **742** may be increased past the transmission deadline **744**, and transmission request **700** will be dropped **882**.

[0226] Alternate embodiments of process **1300** may perform an acceptance test **139** to determine if the modified transmission criteria **770** is still acceptable within the system **100**.

[0227] In further alternate embodiments, the process **1300** drops the transmission request **700** when the file **112**A has not been retrieved before the transmission release time **742**. This rejection can cause a notification signal, e.g. an e-mail message, to be transmitted to the client **180**, informing the client **180** of the dropped request **700**, and cause the client **180** to schedule a next transmission of the file **112**A by interacting with the request receiver process **144**.

[0228] After increasing the release time, step **1340**, execution of process **1300** moves to step **1380** where, if a next history log record **450** exists, it is selected for iteration and execution branches to step **1320**. After all history log records **450** have been iterated **1320** over, execution branches to step **1390** where the process **1300** ends.

[0229] When step **1330** finds that the status code **415** contains a "Success" indicator, execution of process **1300** moves to step **1370**. Step **1370** examines fields in the file list record **350** and the delivery criteria record **914** associated with the selected history record **450** to determine if a file **112**A has been completely transmitted. If the cursor **315** field of the file list record **350** is equal to the size **922** field of the delivery criteria record, all portions of the file **112**A have been transmitted, and execution of process **1300** proceeds to step **1375**. In a preferred embodiment, step **1375** sends a message to the client **180** indicating that a transmission/retransmission of the file **112**A has completed. In alternate embodiments, the process **1300**, step **1375**, may also send messages to the recipients **928** listed in the delivery criteria record **914**. This message would request acknowledgment of the transmitted file **112**A and may be sent conditionally based on the value of the acknowledgments **930** field. After performing step **1375**, execution of the process **1300** continues to step **1380**.

[0230] Step **1375** may optionally produce a bill after each successful transmission, may create a new line items in a pending bill which charged an amount for each transmission, or may send a signal to a billing process **136** to perform the billing. The billing process **136** could examine the history log **400** to determine how many portions of a file **112**A were sent for a transmission request and generate a bill accordingly.

[0231] When the process **1300** determines that a file **112**A has not yet been completely transmitted **1370**, execution of the process branches directly to step **1380** where the process **1300** will perform a next iteration **1320** of a next history record **450**, or end **1390** when all history records **450** have been iterated through.

[0232] In a preferred embodiment, process **1300** is executed by the schedule process (**128**, **134**) on a periodic basis, e.g. every five minutes. In alternate embodiments, process **1300** is executed whenever new history records **450** are added to the history log **400**, or when a the number of new history records **450** within the history log **400** passes a threshold, e.g. when there are at least twenty new history records **450** in the history log **400**.

[0233] In addition to writing history records **450** into the history log **400**, the dispatching process **600** generates other information which may be used for feedback. As the dispatching process **600** transmits portions of files **112**A over the network (**150**, **159**), it modifies the aggregate amount of network use **515** fields of network use criteria records **550**. These modified network use criteria records **550** are used by the schedule dispatch process **1100**, FIG. **11** above, to determine the remaining bandwidth **530** during a time period.

[0234] The dispatching process **600** also updates the cursor field **315** of file list records **350** as it transmits portions of their

associated files **112**A. The cursor field **315** is used by process **1100**, step **1125**, and process **1200**, step **1235**, to determine the quantity of file **112**A data which needs to be transmitted. As portions of the file **112**A are transmitted over time for distinct delivery criteria records **914**, the cursor field **315** of tine delivery criteria records **914** is increased. And, if the schedule dispatch process **1100** is executed after a portion of a file **112**A has been transmitted, because the cursor **315** field will have been updated during the portion transmission, the schedule dispatch process **1100** will not try to reschedule that portion.

[0235] Referring back to the description of FIG. **8**, box **135** is an optional acknowledgment receiver process. This process **135** receives messages (e.g. positive or negative acknowledgments) from clients (**160**, **170**) that indicate successful receipt of a transmission, successful receipt of one or more portions of a transmission; partial receipt of a transmission, and receipt of a transmission with errors (e.g. missing data, damaged data, partial data) in one or more of its portions. Upon receiving acknowledgments (positive or negative), the process **135** examines the associated transmission request **700** and determines if a retransmission of the data file **112**A or a portion of the data file **112**A is warranted. When the process **135** determines that a retransmission is needed or is no longer needed, it signals the estimate transmissions process **1000** to schedule and/or remove delivery criteria **914** associated with the transmission request **700**. The process **135** may also signal the billing process **136** to generate a bill.

[0236] FIG. **14** is a flow chart of an acceptance process **139** which determines if it is possible to schedule a transmission of the information in the transmission request **700** in accordance to the received transmission constraints **770**.

[0237] The acceptance process **139** begins, step **1410**, by iterating over the transmission constraints **770** in the transmission request **700** received by the request receiver process **144**. In a preferred embodiment of the invention, the transmission request **700** contains only one transmission constraint **770**. However, in alternate embodiments, the transmission request **700** may contain multiple transmission constraints **770**, and each is iterated over in turn by step **1410**.

[0238] Step **1420** of the process **139** estimates the cost of performing the transmission request **700** in accordance to the selected transmission constraints (**770**, **1410**). The costs of the transmission can be based on many cost factors and fees. Cost factors which relate to the content generator process **146** include: rental of a network connection **157** (a leaded line, an internet connection) between the client **180** and the server **140**; an on-line or off-line storage fee to maintain the retrieved files **112**A in mass storage **110**; a fee relating to the expected data file size **722** of the file **112**A being retrieved; a fee relating to the expected length of time taken to retrieve the data file **112**A; a fee for preparation work (digitization, encryption) requested by packaging options **720**; and a fee for polling the client **180** to retrieve updated data files **112**A.

[0239] Cost factors which relate to the transmissions of the data file **112**A include: a priority based fee; network usage fees based on peak and off-peak transmission release times **742** and transmission deadlines **744**; fees based on the amount of leeway between the transmission release time **742** and the transmission deadline **744**; number of retransmissions requested (retransmission count **748**); and the acknowledgments **760** requested. The cost may also be influenced by the number of recipients **750** which are to acknowledge the transmissions, and their prior reception history. A client **180** may qualify for a discount if all the recipients **750** in a transmission request **770** have a history of excellent reception and retransmissions **748** are not expected to be necessary. A further cost factor may be the type of report offered to the client **180** detailing the transmissions, retransmissions, and itemized success or failure of recipient **750** reception. Other factors which are considered by the billing process **136** may also be estimated by step **1420**.

[0240] After calculating an estimate of the cost of the transmission, step **1420**, the process **139** checks, step **1430**, to see if the cost is within the (optional) billing cost **734** amount specified in the transmission request **700**. If the estimated cost **1420** is greater than the billing cost **734**, execution of the process **139** branches to step **1460** where an iteration of a next transmission constraint **770** is performed.

[0241] If the estimated cost **1420** is equal to or less than the billing cost **734** (or if the optional billing cost field **734** was omitted), the process **139** tests the transmission request **700** for, step **1435**, other business constraints. For instance, the process **139** may estimate the time required to perform transformations requested in the packaging options field **720** such as encryption or digitization. The transmission request **700** is then checked to see that there is a sufficient amount of time between the retrieval start time **714** and the transmission release time **742** to prepare the file **112**A for transmission. The process **139** may also, step **1435**, estimate the time required for the content generator process **146** to retrieve the data file **112**A, given its estimated data file size **722**, and see that there is enough time to retrieve the data file **112**A before transmitting it.

[0242] In alternate embodiments, the tests of step **1435** are performed before step **1430**.

[0243] If the transmission request **700** passes the tests of step **1435**, the process **139** executes process **1000** to estimate the transmissions which are required to fulfill the transmission constraints **770**. The process **139** then executes process **1100** to schedule the transmission. When execution of process **1110** ends with the transmission being successfully schedule, i.e. it was not dropped (**882** and step **1440**), the transmission constraint **770** are considered acceptable to the system **100** and the transmission request **700** is accepted, step **1450**.

[0244] If during execution of process **1100**, the transmission is dropped (**882** and step **1440**), the acceptance process **139** determines that the transmission constraint **770** cannot be scheduled by the system **100**. Execution of the process **139** moves to step **1460** where an iteration of a next transmission constraint **770** is performed.

[0245] Step **1460** checks the transmission request **700** to see if it contains any transmission constraints **770** which have not yet been iterated over. If so, step **1460** causes execution of the process **139** to branch to step **1410** to perform the next iteration. When all transmission constraints **770** have been iterated over **1410**, execution of the process **139** moves to step **1470** where the transmission request **700** is rejected. All candidate transmission constraints **770** have been examined and none have found acceptable, so the transmission request **700** is rejected and a rejection signal is sent to the client **180** by the request receiver process **144**. The client **180** can then submit a new transmission request **700** with alternate transmission constraints **770**.

[0246] In alternate embodiments, the acceptance process **139** marks each transmission constraint **770** with an indication of why it was considered unacceptable. This marking can

indicate that a constraint **770** was too costly and not accepted by step **1430**, for example. Or the marking can indicate that the cost was sufficient but there was not enough available network use, determined by step **1440**, to schedule the transmission request **700**. The marked up transmission constraints **770** are returned to the client **180** by the request receiver process **144** and provide the client **180** with information which can be used to negotiate an acceptable transmission request **700**.

[0247] Alternate embodiments may also return a copy (or a detailed or summarized report) of the network use criteria table (**500**, **1110**) used in the schedule dispatch process **1100**, when transmission requests **700** are rejected. This report would let the client **180** know when the network has available bandwidth and would let the client **180** fine-tune a next transmission request **700** that would be more acceptable.

[0248] Further embodiments of the acceptance process **139** may execute processes **1000** and **1100** for transmissions to be performed in the near-term only (e.g. within one week), and perform an alternate acceptance test for long-term transmissions. This alternate test would be used to roughly forecast the network bandwidth availability.

[0249] In a non-limiting example, a subscriber, such as a software provider (client **180**), wants to provide software updates to its network (**150**, **159**) connected customers (**160**, **170**). The software provider sends a transmission request **700** to the request receiver process **144**. The file **112**A containing the software updates is 100 megabytes long. The connected customers (e.g. recipients **750**) can receive at speeds up to 128 kilobits per second (e.g. bandwidth constraints **752**). The software provider requests (through packaging options field **720**) that the software updates be encrypted and digitally signed. The software provider also requests (through acknowledgments field **760**) that each recipient **750** acknowledge receipt of the file **112**A. The software provider specifies a retrieval start time **714** of 08:00 AM, a transmission release time **742** of 08:30 AM, and a transmission deadline **744** of 09:00 AM.

[0250] The request receiver process **144** receives the software provider's transmission request **700** and passes it to the acceptance process **139**. The acceptance process **139** rejects the transmission request **700** because the content generator process **146** requires at least forty-five minutes to retrieve the data file **112**A, encrypt it, and sign it (rejection due to failure of tests in step **1435**); and because (rejection due to failure in step **1440**) the 100 megabyte file **112**A cannot be transmitted in thirty minutes at 128 kilobits per second.

[0251] After the transmission request **700** is rejected by acceptance process **139**, the request receiver notifies the software provider (client **180**) of the rejection and indicates the minimal time requirements needed to satisfy the tests of step **1435** and **1440**. A person at the software provider submits a second transmission request **700** with a transmission release time **742** of 11:00 AM and a transmission deadline **744** of 02:30 PM. This second transmission request **700** is accepted by process **139**.

[0252] Referring now to FIG. **8**, an additional action taken **888** is for the delivery status module **137** to notify the acceptance process **1440** when a delivery criteria record **914** associated with a candidate transmission constraint (**1410**, **770**) was dropped.

[0253] Alternate embodiments of the system architecture **800** may include multiple scheduler processes (**128**, **134**), request receiver processes **144** and acceptance processes **139**, content generators **146**, dispatch processes **600** (**600**A, **600**B), acknowledgment receiver processes **135**, and delivery status modules **137**, communicating with each other. One request receiver process **144** may act as a broker and forward a received transmission request **700** to multiple acceptance processes **139** in an attempt to have a transmission request **700** accepted at a preferred billing rate or transmission criteria **770**. If a first acceptance process **139** rejects the transmission request **700**, the request **700** would be passed by the request receiver broker **144** to a second acceptance process **139** which may be connected to a system **100** which offers better rates or have more available bandwidth.

[0254] A broker request receiver process **144** may also break a transmission request **700** into two or more new transmission requests **700** which may be accepted, rejected, and/or serviced independently. For example, suppose a company wishes to deliver a digitized video of a product announcement to people who have registered on its mailing list. The recipients for the product announcement may include satellite connected users (e.g. **160**), terrestrial users (e.g. **170**) connected to the Internet Multicast Backbone (M-Bone), and terrestrial users (e.g. **170**) connected to the Internet via America On-Line (AOL). The company may create a transmission request **700** which lists all of its users and send the request **700** to a broker request receiver process **144**. This broker request receiver process **144** may generate three transmission requests **700**, the request **700** listing the satellite connected users, the M-Bone connected terrestrial users, and the AOL users, in the recipients **750** field, respectively. The broker request receiver process **144** would then submit the new transmission requests **700** to acceptance processes **139** which were connected to the appropriate networks (**150**, **159**).

[0255] A broker request receiver process **144** may also break a transmission request **700** into two or more new transmission requests **700** by other means (besides recipient **750** network **150**,**159** connectivity). For instance, a broker request receiver process **144** which receives a transmission request **700** asking for a retransmission **748** may generate two transmission requests **700**, each asking for zero retransmissions **748**. In essence, the broker request receiver process **144** performs a negotiation process with one or more acceptance processes **139** on behalf of a client **180**.

[0256] Other businesses processes may also be built around the system **100**. A company may wish to have data files on its agent computers synchronized with a central data source. Each time a file **112**A changes at the central data source (client **180**), a transmission request **700** could be generated to have the new data file **112**A transmitted over the network (**150**, **159**) to the company's agents (**160**, **170**). This file **112**A may or may not be encrypted to maintain privacy.

[0257] Another company may add a finishing process to the system **100** which receives a transmitted data file **112**A and forwards it on a local area network to other network connected clients or performs some other final manipulation. A sample finishing process may be for received data files **112**A at a client (**160**, **170**) which contain e-mail messages to be forwarded over a local area network. Or, when received data files **112**A contain digitized video, the finishing process may be to convert the files **112**A into analog NTSC video for displayed in an auditorium or conference room, or storage on analog video tape.

[0258] The system **100** makes it easy to transmit data files **112**A to a large number of recipients and provides an assurance that the transmission will take place. And, it provides a way to manage the network (e.g. Satellite network) bandwidth. This easy-to-use system opens the satellite marketplace up to many new business opportunities. Small to mid-size businesses can now transmit their digital information over the satellite easily and economically.

[0259] Given this disclosure alternative equivalent embodiments will become apparent to those skilled in the art. These embodiments are also within the contemplation of the inventors.

What is claimed is:

1-19. (canceled)

20. A method comprising:

receiving from a client a request for transmitting digital information from a source address to at least one recipient, the request comprising the source address, an earliest start time, a maximum cost, a priority, and an identification of the at least one recipient, the digital information having a size;

responsive to the request, determining an end time at which the digital information should be completely transmitted to the at least one recipient;

based at least on the size and a network capacity, determining a total time required to transmit the digital information;

based at least on the size, the determined end time, the determined total time, the priority, and the cost, determining whether the digital information can be completely transmitted to the at least one recipient after the earliest start time and prior to the determined end time;

in response to a determination that the digital information cannot be completely transmitted to the at least one recipient after the earliest start time and prior to the determined end time, notifying the client; and

in response to a determination that the digital information can be transmitted to the at least one recipient:

begin transmitting the digital information at a time that is prior to the end time and later than the earliest start time; and

billing the client an amount that does not exceed the maximum cost.

21. The method of claim **20**, wherein determining the end time further comprises determining the end time by using the priority and the start time.

22. The method of claim **21**, wherein the request further comprises a transmission deadline, and wherein determining the end time further comprises determining the end time by using the transmission deadline.

23. The method as in claim **20**, further comprising receiving an acknowledgment of the transmission.

24. The method as in claim **23**, wherein billing further comprises producing a bill on receipt of the acknowledgment.

25. The method as in claim **20**, where the priority indicates that the digital information is to be transmitted within a time period.

26. The method as in claim **25**, where the time period is at least of: over night, two days and one week.

27. The method as in claim **20**, where the priority is a freight priority that requires the digital information to be transmitted within a freight time period with no acknowledgments.

28. The method as in claim **20**, wherein the request further includes information from the client regarding how the client can be billed.

29. The method as in claim **28**, wherein the information from the client comprises an account identifier and billing further comprises billing the amount to the account identified by the account identifier.

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