



22783 U.S. PTO

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PTO/SB/16(6-95)**PROVISIONAL APPLICATION COVER SHEET**

This is a request for filing a PROVISIONAL APPLICATION under 37 CFR 1.53(b)(2).

22151 U.S. PTO
60/566831

Docket Number:	2082.2.1p				
INVENTOR(s)/APPLICANT(s)					
LAST NAME, FIRST NAME, MIDDLE INITIAL	RESIDENCE (CITY AND EITHER STATE OR FOREIGN COUNTRY)				
Major, Robert D. Hurst, Mark B.	Orem, Utah Cedar Hills, Utah				
TITLE OF THE INVENTION (280 characters max.)					
APPARATUS, SYSTEM, AND METHOD FOR DYNAMIC RATE SHIFTING OF STREAMING CONTENT					
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STATE	UTAH	ZIP CODE	84101	COUNTRY	U.S.A.
ENCLOSED APPLICATION PARTS (check all that apply)					
☒ Specification	No. of Pages:	16	☒ Small Entity Status Claimed by Applicant	☒ Return Postcard	
☒ Drawing(s)	No. of Sheets:	7	☒ Other (specify)	CERTIFICATE OF EXPRESS MAILING	
METHOD OF PAYMENT (check all that apply)					
☒ Fee Transmittal Form Enclosed (in duplicate)			☒ Check Enclosed		

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

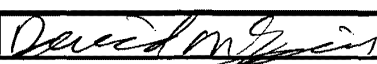
Yes, the name of the U.S. Government Agency and the Government contract number are:

Rev .4/30/4

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SIGNATURE OF ATTORNEY OR AGENT			
Signature:			
Attorney/Reg. No.:	David J. McKenzie, Registration No.: 46,919	Dated:	April 30, 2004

CERTIFICATE OF MAILING			
I hereby certify that this correspondence is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service pursuant to 37 CFR 1.10 in an envelope addressed to: Mail Stop Provisional Patent Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below.			
Signature:			
Typed or Printed Name:	David J. McKenzie	Dated:	April 30, 2004
Express Mail Mailing Number:	ER730013143US		

PROVISIONAL APPLICATION FILING ONLY

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0002/PTO(modified) Rev. 10/95		U.S. Department of Commerce Patent and Trademark Office		Complete if Known	
FEE TRANSMITTAL TOTAL AMOUNT OF PAYMENT Subtotal (1) + Subtotal (2) + Subtotal (3) = \$ 80				Application Number	
				Filing Date	
				First Named Inventor	
				Group Art Unit	
				Examiner Name	
				Attorney Docket Number	
				2082.2.1p	

METHOD OF PAYMENT	FEE CALCULATION (continued)																																																																																								
1. The Commissioner is hereby authorized to: ☐ Charge the indicated fees to the below mentioned deposit account. ☐ Charge any additional fee required under 37 CFR 1.16 - 1.21 or credit any over payments to the below mentioned deposit account. ¹ ☐ Charge the Issue Fee set in 37 CFR 1.18 at the Mailing of the Notice of Allowance, 37 CFR 1.311(b) to the below mentioned deposit account. Deposit Account Number: Deposit Account Name: A Duplicate Copy of this authorization is attached 2. ☒ Payment Enclosed: ☐ Check ☐ Other	3. ADDITIONAL FEES <table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th style="width:15%;">Large Entity Fee Code/Fee</th> <th style="width:15%;">Small Entity Fee Code/Fee</th> <th style="width:45%;">Fee Description</th> <th style="width:25%;">Fee Due</th> </tr> </thead> <tbody> <tr><td>105/\$130</td><td>205/\$65</td><td>Surcharge - late filing fee or oath</td><td></td></tr> <tr><td>127/\$50</td><td>227/\$25</td><td>Surcharge-late provisional filing fee or cover sheet</td><td></td></tr> <tr><td>147/\$2,520</td><td>147/\$2,520</td><td>For filing a request for reexamination</td><td></td></tr> <tr><td>115/\$110</td><td>215/\$55</td><td>Extension for response within first month[†]</td><td></td></tr> <tr><td>116/\$400</td><td>216/\$200</td><td>Extension for response within second month[†]</td><td></td></tr> <tr><td>117/\$920</td><td>217/\$460</td><td>Extension for response within third month[†]</td><td></td></tr> <tr><td>118/\$1,440</td><td>218/\$720</td><td>Extension for response within fourth month[†]</td><td></td></tr> <tr><td>128/\$1,960</td><td>228/\$980</td><td>Extension for response within fifth month[†]</td><td></td></tr> <tr><td>119/\$320</td><td>219/\$160</td><td>Notice of Appeal</td><td></td></tr> <tr><td>141/\$1,280</td><td>241/\$640</td><td>Petition to revive unintentionally abandoned application</td><td></td></tr> <tr><td>142/\$1,280</td><td>242/\$640</td><td>Utility Issue Fee (Or Reissue)</td><td></td></tr> <tr><td>143/\$460</td><td>243/\$230</td><td>Design Issue Fee</td><td></td></tr> <tr><td>122/\$130</td><td>122/\$130</td><td>Petitions to the Commissioner</td><td></td></tr> <tr><td>123/\$50</td><td>123/\$50</td><td>Petitions related to provisional applications</td><td></td></tr> <tr><td>126/\$180</td><td>126/\$180</td><td>Submission of Information Disclosure Statement</td><td></td></tr> <tr><td>581/\$40</td><td>581/\$40</td><td>Recording each patent assignment per property (times number of properties)</td><td></td></tr> <tr><td>146/\$740</td><td>246/\$370</td><td>Filing a submission after final rejection (37 CFR 1.129(a))</td><td></td></tr> <tr><td>149/\$740</td><td>249/\$370</td><td>For each additional invention to be examined (37 CFR 1.129(b))</td><td></td></tr> <tr><td colspan="4">Other fee (specify):</td></tr> <tr><td colspan="4">Other fee (specify):</td></tr> <tr> <td colspan="3" style="text-align: right;">SUBTOTAL (3)</td> <td>(\$) 0</td> </tr> </tbody> </table>	Large Entity Fee Code/Fee	Small Entity Fee Code/Fee	Fee Description	Fee Due	105/\$130	205/\$65	Surcharge - late filing fee or oath		127/\$50	227/\$25	Surcharge-late provisional filing fee or cover sheet		147/\$2,520	147/\$2,520	For filing a request for reexamination		115/\$110	215/\$55	Extension for response within first month [†]		116/\$400	216/\$200	Extension for response within second month [†]		117/\$920	217/\$460	Extension for response within third month [†]		118/\$1,440	218/\$720	Extension for response within fourth month [†]		128/\$1,960	228/\$980	Extension for response within fifth month [†]		119/\$320	219/\$160	Notice of Appeal		141/\$1,280	241/\$640	Petition to revive unintentionally abandoned application		142/\$1,280	242/\$640	Utility Issue Fee (Or Reissue)		143/\$460	243/\$230	Design Issue Fee		122/\$130	122/\$130	Petitions to the Commissioner		123/\$50	123/\$50	Petitions related to provisional applications		126/\$180	126/\$180	Submission of Information Disclosure Statement		581/\$40	581/\$40	Recording each patent assignment per property (times number of properties)		146/\$740	246/\$370	Filing a submission after final rejection (37 CFR 1.129(a))		149/\$740	249/\$370	For each additional invention to be examined (37 CFR 1.129(b))		Other fee (specify):				Other fee (specify):				SUBTOTAL (3)			(\$) 0
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FEE CALCULATION (fees effective 11/12/98)			
1. FILING FEE			
Large Entity Fee Code/Fee	Small Entity Fee Code/Fee	Fee Description	Fee Due
101/\$740	201/\$340	Utility Filing	
106/\$330	206/\$165	Design Filing	
108/\$740	208/\$370	Reissue Filing	
114/\$160	214/\$80	Provisional Filing	80
SUBTOTAL (1)			80
2. CLAIMS			
Large Entity Fee Code/Fee	Small Entity Fee Code/Fee	Fee Description	Fee Due
103/\$18	203/\$9	Claims in excess of 20	
102/\$84	202/\$42	Independent claims in excess of 3	
104/\$280	204/\$140	Multiple dependent claim	
109/\$84	209/\$42	Reissue independent claims over original patent	
110/\$18	210/\$9	Reissue claims in excess of 20 and over original patent	

(Col. 1)		(Col. 2)		(Col. 3)		Fee	Fee Due
For	No. of Existing Claims		Highest No. Previously Paid For	Extra**			
TOTAL		minus*	20 or	=	x	=	
INDEP		minus*	3 or	=	x	=	
☐ First presentation of multiple dependent claim							
SUBTOTAL (2)							(\$) 0

* Subtract the greater number of Col. 2
 ** If the difference between Col. 1 and Col. 2 is less than zero, then enter "0" in Col. 3

SUBMITTED BY		Complete (if applicable)	
Typed or Printed Name	David J. McKenzie	Reg. Number	46,919
Signature		Date	4/30/04
		April 30, 2004	

¹ Request for Extension of Time per 37 CFR 1.136 (a)(3) made hereby

PROVISIONAL PATENT APPLICATION

Docket No.: 2082.2.1p

CERTIFICATE OF MAILING BY "EXPRESS MAIL"

"Express Mail" Mailing Label No.: ER730013143US

Date of Deposit: April 30, 2004

I hereby certify that this provisional patent application in the name of Robert D. Major and Mark B. Hurst for APPARATUS, SYSTEM, AND METHOD FOR DYNAMIC RATE SHIFTING OF STREAMING CONTENT, together with all the provisional transmittals and Check No. 2210 for \$80 are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. § 1.10 on the date indicated above in an envelope addressed to Box Provisional Patent Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Respectfully submitted,



David J. McKenzie
Reg. No. 46,919
Attorney for Applicant

Date: April 30, 2004

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Express Mailing No.: ER730013143US

PATENT APPLICATION
Kunzler & Associates Docket No.: 2082.2.1p

UNITED STATES PROVISIONAL PATENT APPLICATION

of

**R. DREW MAJOR,
AND
MARK B. HURST**

for

**APPARATUS, SYSTEM, AND METHOD FOR
DYNAMIC RATE SHIFTING OF STREAMING CONTENT**

APPARATUS, SYSTEM, AND METHOD FOR DYNAMIC RATE SHIFTING OF STREAMING CONTENT

DETAILED DESCRIPTION OF THE INVENTION

[0001] Many of the functional units described in this specification have been labeled as modules, in order to more particularly emphasize their implementation independence. For example, a module may be implemented as a hardware circuit comprising custom VLSI circuits or gate arrays, off-the-shelf semiconductors such as logic chips, transistors, or other discrete components. A module may also be implemented in programmable hardware devices such as field programmable gate arrays, programmable array logic, programmable logic devices or the like.

[0002] Modules may also be implemented in software for execution by various types of processors. An identified module of executable code may, for instance, comprise one or more physical or logical blocks of computer instructions which may, for instance, be organized as an object, procedure, or function. Nevertheless, the executables of an identified module need not be physically located together, but may comprise disparate instructions stored in different locations which, when joined logically together, comprise the module and achieve the stated purpose for the module.

[0003] Indeed, a module of executable code could be a single instruction, or many instructions, and may even be distributed over several different code segments, among different programs, and across several memory devices. Similarly, operational data may be identified and illustrated herein within modules, and may be embodied in any suitable form and organized within any suitable type of data structure. The operational data may be collected as a single data set, or may be distributed over different locations including over different storage devices, and may exist, at least partially, merely as electronic signals on a system or network.

[0004] Reference throughout this specification to “one embodiment,” “an embodiment,” or similar language means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, appearances of the phrases “in one embodiment,” “in an embodiment,” and similar language throughout this specification may, but do not necessarily, all refer to the same embodiment.

[0005] Furthermore, the described features, structures, or characteristics of the invention may be combined in any suitable manner in one or more embodiments. In the following description, numerous specific details are provided, such as examples of programming, software modules, user selections, network transactions, database queries, database structures, hardware modules, hardware circuits, hardware chips, etc., to provide a thorough understanding of embodiments of the invention. One skilled in the relevant art will recognize, however, that the invention can be practiced without one or more of the specific details, or with other methods, components, materials, and so forth. In other instances, well-known structures, materials, or operations are not shown or described in detail to avoid obscuring aspects of the invention.

[0006] Figure 1 depicts a schematic block diagram illustrating one embodiment of a system 100 for dynamic rate shifting of streaming content in accordance with the present invention. In one embodiment, the system 100 comprises a content server 102 and an end user 104. The content server 102 and the end user station 104 may be coupled by a data communications network. The data communications network may include the Internet 106 and connections 108 to the Internet 106. Alternatively, the content server 102 and the end user 104 may be located on a common local area network, wireless area network, cellular network, virtual local area network, or the like. The end user station 104 may comprise a personal computer (PC), an entertainment system configured to communicate over a network, or a portable electronic device configured to present content.

[0007] In the depicted embodiment, the system 100 also includes a publisher 110, and a web server 116. The publisher 110 may be a creator or distributor of content. For example, if the content to be streamed were a broadcast of a television program, the publisher 110 may be a television or cable network channel such as NBC®, or MTV®. Content may be transferred over the Internet 106 to the content server 102, where the content is received by a content module 112. The content module 112 may be configured to receive, process, and store content. In one embodiment, processed content is accessed by a client module 114 configured to play the content on the end user station 104. In a further embodiment, the client module 114 is configured to receive different portions of a content stream from a plurality of locations simultaneously. For example, the client module 114 may request and receive content from any of the plurality of web servers 116.

[0008] Figure 2a is a schematic block diagram graphically illustrating one embodiment of a content file 200. In one embodiment, the content file 200 is distributed by the publisher 110. The content file 200 may comprise a television broadcast, sports event, movie, music, concert, etc. The content file 200 may also be live or archived content. The content file 200 may comprise uncompressed video and audio, or alternatively, video or audio. Additionally, the content file 200 may be compressed. Examples of a compressed content file 200 include, but are not limited to, DivX®, Windows Media Video 9®, Quicktime 6.5 Sorenson 3®, or Quicktime 6.5/ MPEG-4® encoded content.

[0009] Figure 2b is a schematic block diagram illustrating one embodiment of a plurality of streams 202 having varying degrees of quality and bandwidth. In one embodiment, the plurality of streams 202 comprises a low quality stream 204, a medium quality stream 206, and a high quality stream 208. Each of the streams 204, 206, 208 is a copy of the content file 200 encoded and compressed to varying bit rates. For example, the low quality stream 204 may be encoded and compressed to a bit rate of 100 kilobits per second (kbps), the medium quality stream 206 may be encoded and compressed to a bit rate of 200 kbps, and the high quality stream 208 may be encoded and compressed to 600 kbps.

[0010] Figure 2c is a schematic block diagram illustrating one embodiment of a stream 210 divided into a plurality of streamlets 212. Each streamlet 212 may comprise a file containing a portion of the content contained in stream 210, encapsulated as an independent media object. The content in a streamlet 212 may have a unique time index in relation to the beginning of the content contained in stream 210. In one embodiment, the content contained in each streamlet 212 has duration of two seconds. For example, streamlet 0 may have a time index of 00:00 representing the beginning of content playback, and streamlet 1 may have a time index of 00:02, and so on. Alternatively, the time duration of the streamlets 212 may be any duration smaller than the entire playback duration of the content in stream 210.

[0011] Figure 3 is a schematic block diagram illustrating in greater detail one embodiment of the content module 112 in accordance with the present invention. The content module 112 may comprise a stream module 302, a streamlet module 304, an encoder module 306, a streamlet database 308, and the web server 116. In one embodiment, the stream module 302 is configured to receive the content file 200 from the publisher 110 and generate the plurality of streams 202 of varying qualities. The original content file 200 from the publisher may be digital in form and may comprise content having a high bit rate, for example, 2mbs. The content may be transferred from the publisher 110 to the content module 112 over the Internet 106. Such transfers of data are well known in the art and do not require further discussion herein. Alternatively, the content may comprise a captured broadcast.

[0012] In the depicted embodiment, the plurality of streams 202 may comprise the low quality stream 204, the medium quality stream 206, and the high quality stream 208. Alternatively, the plurality of streams 202 may comprise any number of streams deemed necessary to accommodate end user bandwidth. The streamlet module 304 may be configured to receive the plurality of streams 202 from the stream module and generate a plurality of streams 312, each stream comprising a plurality of streamlets 212. As described

with reference to Figure 2c, each streamlet 212 may comprise a pre-defined portion of the stream. The encoder module 306 is configured to encode each streamlet from the plurality of streams 312 and store the streamlets in the streamlet database 308. The encoding module 306 may utilize encoding schemes such as DivX®, Windows Media Video 9®, Quicktime 6.5 Sorenson 3®, or Quicktime 6.5/ MPEG-4®. Alternatively, a proprietary encoding scheme may be employed.

[0013] The content module 112 may also include a metadata module 312 and a metadata database 314. In one embodiment, metadata comprises static searchable content information. For example, metadata includes, but is not limited to, air date of the content, title, actresses, actors, length, and episode name. Metadata is generated by the publisher 110, and may be configured to define an end user environment. In one embodiment, the publisher 100 may define an end user navigational environment for the content including menus, thumbnails, sidebars, advertising, etc. Additionally, the publisher 110 may define functions such as fast forward, rewind, pause, and play that may be used with the content file 200. The metadata module 312 is configured to receive the metadata from the publisher 110 and store the metadata in the metadata database 314. In a further embodiment, the metadata module 312 is configured to interface with the client module 114, allowing the client module 114 to search for content based upon at least one of a plurality of metadata criteria. Additionally, metadata may be generated by the content module 112 through automated process(es) or manual definition.

[0014] Once the streamlets 212 have been received and processed, the client module 114 may request streamlets 212 using HTTP from the web server 116. Such use of client side initiated requests requires no additional configuration of firewalls. Additionally, since the client module 114 initiates the request, the web server 116 is only required to retrieve and serve the requested streamlet. In a further embodiment, the client module 114 may be configured to retrieve streamlets 212 from a plurality of web servers 310, each web server 116 may be located in various locations across the Internet 106. The streamlets 212 are

essentially static files. As such, no specialized media server or server-side intelligence is required for a client module 114 to retrieve streamlets 212. Streamlets 212 may be served by the web server 116 or cached by cache servers of Internet Service Providers (ISPs) and served by the cache server. Use of cache servers is well known to those skilled in the art, and will not be discussed further herein. This creates a highly scalable solution that is not hindered by massive amounts of client module 114 requests.

[0015] Figure 4 is a schematic block diagram graphically illustrating one embodiment of a client module 114 in accordance with the present invention. The client module 114 may comprise an agent controller module 402, a streamlet cache module 404, and a network controller module 406. In one embodiment, the agent controller module 402 is configured to interface with a viewer 408, and transmit streamlets 212 to the viewer 408. In a further embodiment, the client module 114 may comprise a plurality of agent controller modules 402, each agent controller module 402 configured to interface with one viewer 408. Alternatively, the agent controller module 402 may be configured to interface with a plurality of viewers 408. The viewer 408 may be a media player (not shown) operating on a pc or handheld electronic device.

[0016] The agent controller module 402 is configured to select a quality level of streamlets to transmit to the viewer 408. The agent controller module 402 requests lower or higher quality streams based upon continuous observation of time intervals between successive receive times of each requested streamlet. The method of requesting higher or lower quality streams will be discussed in greater detail below with reference to Figure 7.

[0017] The agent controller module 402 may be configured to receive user commands from the viewer 408. Such commands may include play, fast forward, rewind, pause, and stop. In one embodiment, the agent controller module 402 requests streamlets 212 from the streamlet cache module 404 and arranges the received streamlets 212 in a staging module 409. The staging module 409 may be configured to arrange the streamlets 212 in order of ascending playback time. In the depicted embodiment, the streamlets 212 are

numbered 0, 1, 2, 3, 4, etc. However, each streamlet 212 may be identified with a unique filename.

[0018] Additionally, the agent controller module 402 may be configured to anticipate streamlet 212 requests and pre-request streamlets 212. By pre-requesting streamlets 212, the user may fast-forward, skip randomly, or rewind through the content and experience no buffering delay. In a further embodiment, the agent controller module 402 may request the streamlets 212 that correspond to time index intervals of 30 seconds within the the total play time of the content.. Alternatively, the agent controller module 402 may request streamlets at any interval less than the length of the time index. This enables a “fast-start” (no buffering wait) capability when starting or fast-forwarding through content file 200. In a further embodiment, the agent controller module 402 may be configured to pre-request streamlets 212 corresponding to specified index points within the content or within other content in anticipation of the end user 104 selecting new content to view.

[0019] In one embodiment, the streamlet cache module 404 is configured to receive streamlet 212 requests from the agent controller module 402. Upon receiving a request, the streamlet cache module 404 first checks a streamlet cache 410 to verify if the streamlet 212 is present. In a further embodiment, the streamlet cache module 404 handles streamlet 212 requests from a plurality of agent controller modules 402. Alternatively, a streamlet cache module 404 may be provided for each agent controller module 402. If the requested streamlet 212 is not present in the streamlet cache 410, the request is passed to the network controller module 406. In order to enable fast forward and rewind capabilities, the streamlet cache module 404 is configured to store the plurality of streamlets 212 in the streamlet cache 410 for a specified time period after the streamlet 212 has been viewed. However, once the streamlets 212 have been deleted, they may be requested again from the web server 116.

[0020] The network controller module 406 may be configured to receive streamlet requests from the streamlet cache module 404 and open a connection to the web server 116 or other remote streamlet 212 database (not shown). In one embodiment, the network

controller module 406 opens a TCP/IP connection to the web server 116 and generates a standard HTTP GET request for the requested streamlet 212. Upon receiving the requested streamlet 212, the network controller module 406 passes the streamlet 212 to the streamlet cache module 404 where it is stored in the streamlet cache 410. In a further embodiment, the network controller module 406 is configured to process and request a plurality of streamlets 212 simultaneously.

[0021] In one embodiment, the client module 114 is configured to use multiple TCP connections between the client module 114 and the web server 116 (or web cache—the intervention of a cache is transparent to the client). By requesting more than one streamlet 212 at a time (“parallel retrieval”), efficiency is raised to near maximum and latency is virtually eliminated. In a further embodiment, the client module allows a maximum of three outstanding streamlet 212 requests. The client module 114 may maintain additional open TCP connections as “spares” to be available should another connection fail. Streamlet 212 requests are rotated among all open connections to keep the TCP flow logic for any particular connection from falling into a slow-start or close mode.

[0022] When a TCP connection fails completely, a new request may be sent on a different connection for the same streamlet 212. In a further embodiment, if a request is not being satisfied in a timely manner, a redundant request may be sent on a different connection for the same streamlet 212. If the first streamlet 212 request’s response arrives before the redundant request’s response, the redundant request can be aborted. If the redundant request’s response arrives before the first request’s response, the first request may be aborted.

[0023] Several streamlet 212 requests may be sent on a single TCP connection and the responses will flow back in matching order along the same connection. This eliminates all but the first request latency. Because multiple responses are always being transmitted, the processing latency of each new streamlet 212 response after the first is not a factor in performance. This technique is known in the industry as “pipelining.” Pipelining offers efficiency in request-response processing by eliminating most of the effects of request

latency. However, pipelining has serious vulnerabilities. Transmission delays affect all of the responses. If the single TCP connection fails, *all* of the outstanding requests and responses are lost. There is a serial dependency between the requests.

[0024] Multiple TCP connections may be opened between the client module 114 and the web server 116 to achieve the latency-reduction efficiency benefits of pipelining while maintaining the independence of each streamlet 212 request. Several streamlet 212 requests may be sent concurrently, each request on a different TCP connection. This technique is labeled “virtual pipelining” and is an innovation of the present invention. Multiple responses may be in transit concurrently, assuring that communication bandwidth between the client module 114 and the web server 116 is always being utilized. Virtual pipelining eliminates the vulnerabilities of traditional pipelining. A delay in, or complete failure of, one response does not affect the transmission of other responses because each response occupies an independent TCP connection. Any transmission bandwidth not in use by one of multiple responses (whether due to delays or TCP connection failure) may be utilized by other outstanding responses.

[0025] In order to maintain a proper balance between efficiency (maximized bandwidth utilization) and response time, the issuance of new streamlet 212 requests must be timed such that the web server 116 will not be transmitting the response before the client module 114 has fully received a response to one of the previously outstanding streamlet 212 requests. For example, if three streamlet 212 requests are outstanding, the client module 114 should issue the next (fourth request) slightly before one of the three responses is fully received and “out of the pipe”. In other words, request timing is adjusted to keep three responses in transit. Sharing of bandwidth among four responses diminishes the net response time of the other three responses. The timing adjustment may be calculated dynamically by observation, and request timing adjusted accordingly to maintain the proper balance of efficiency and response times.

[0026] Figure 5 is a schematic flow chart diagram illustrating one embodiment of a method 500 for processing content in accordance with the present invention. In one embodiment the method 500 starts 502, and the content module 112 receives 504 content from the publisher 110. Receiving content 504 may comprise receiving 504 a digital copy of the content file 200, or digitizing a physical copy of the content file 200. Alternatively, receiving 504 content may comprise capturing a radio or television broadcast. Once received 504, the stream module 302 generates 506 a plurality of streams 202, each stream 202 having a different quality. The quality may be predefined, or automatically set according to end user bandwidth, or in response to pre-designated publisher guidelines

[0027] The streamlet module 304 receives the streams 202 and generates 508 a plurality of streamlets 212. In one embodiment, generating 508 streamlets comprises dividing the stream 202 into a plurality of two second streamlets 212. Alternatively, the streamlets may have any length less than or equal to the length of the stream 202. The encoder module 306 then encodes 510 the streamlets according to a compression algorithm. In a further embodiment, the algorithm comprises a proprietary codec such as WMV9®. The encoder module 306 then stores 512 the encoded streamlets in the streamlet database 308. Once stored 512, the web server 116 may then serve 514 the streamlets. In one embodiment, serving 514 the streamlets comprises receiving streamlet requests from the client module 114, retrieving the requested streamlet from the streamlet database 308, and subsequently transmitting the streamlet to the client module 114. The method 500 then ends 516.

[0028] Figure 6 is a schematic flow chart diagram illustrating one embodiment of a method 600 for viewing a plurality of streamlets in accordance with the present invention. The method 600 starts and an agent control module 402 is provided 604 and associated with a viewer 408 and having a staging module 409. The agent controller module 402 then requests 606 a streamlet from the streamlet cache module 404. Alternatively, the agent controller module 402 may simultaneously request 606 a plurality of streamlets from the streamlet cache module 404. If the streamlet is stored 608 locally in the streamlet cache 410,

the streamlet cache module 404 retrieves 610 the streamlet and sends the streamlet to the agent controller module 402. Upon retrieving 610 or receiving a streamlet, the agent controller module 402 makes 611 a determination of whether or not to shift to using a higher or lower quality (rate) stream 202. This determination will be described below in greater detail with reference to Figure 7.

[0029] In one embodiment, the staging module 409 then arranges 612 the streamlets into the proper order, and the agent controller module 402 delivers 614 the streamlets to the viewer 408. In a further embodiment, delivering 614 streamlets to the end user comprises playing video and or audio streamlets on the viewer 408. If the streamlets are not stored 608 locally, the streamlet request is passed to the network controller module 406. The network controller module 406 then requests 616 the streamlet from the web server 116. Once the streamlet is received, the network controller module 406 passes the streamlet to the streamlet cache module 404. The streamlet cache module 404 archives 618 the streamlet. Alternatively, the streamlet cache module 404 archives 618 the streamlet and passes the streamlet to the agent controller module 402, and the method 600 then continues from step 610 as described above.

[0030] Referring now to Figure 7, shown therein is a schematic flow chart diagram illustrating one embodiment of a method 611 for requesting streamlets within a dynamic rate shifting content streaming environment in accordance with the present invention. The method 611 starts and the agent controller module 402 receives 704 a streamlet as described above with reference to Figure 6. The agent controller module 402 then monitors 706 the receive time of the requested streamlet. In one embodiment, the agent controller module 402 monitors the time intervals Δ between successive receive times for each streamlet response. Ordering of the responses in relation to the order of their corresponding requests is not relevant.

[0031] Because network behavioral characteristics fluctuate, sometimes quite suddenly, any given Δ may vary substantially from another. In order to compensate for this

fluctuation, the agent controller module 402 calculates 708 a performance ratio r across a window of n samples for streamlets of playback length S . In one embodiment, the performance ratio r is calculated using the equation

$$r = S \frac{n}{\sum_{i=1}^n \Delta_i}.$$

[0032] Due to multiple simultaneous streamlet processing, and in order to better judge the central tendency of the performance ratio r , the agent control module 402 may calculate a geometric mean, or alternatively an equivalent averaging algorithm, across a window of size m , and obtain a performance factor ϕ :

$$\phi_{current} = \left(\prod_{j=1}^m r_j \right)^{\frac{1}{m}}.$$

[0033] The policy determination about whether or not to upshift 710 playback quality begins by comparing $\phi_{current}$ with a trigger threshold Θ_{up} . If $\phi_{current} \geq \Theta_{up}$, then an up shift to the next higher quality stream may be considered 716. In one embodiment, the trigger threshold Θ_{up} is determined by a combination of factors relating to the current read ahead margin (i.e. the amount of contiguously available streamlets that have been sequentially arranged by the staging module 409 for presentation at the current playback time index), and a minimum safety margin. In one embodiment, the minimum safety margin may be 24 seconds. The smaller the read ahead margin, the larger Θ_{up} is to discourage upshifting until a larger read ahead margin may be established to withstand network disruptions. If the agent controller module 402 is able to sustain 716 upshift quality, then the agent controller module 402 will upshift 717 the quality and subsequently request higher quality streams. The determination of whether use of the higher quality stream is sustainable 716 is made by comparing an estimate of the higher quality stream's performance factor, ϕ_{higher} , with Θ_{up} . If $\phi_{higher} \geq \Theta_{up}$ then use of the higher quality stream is considered sustainable. If the decision of

whether or not the higher stream rate is sustainable 716 is “no”, the agent control module 402 will not attempt to upshift 717 stream quality. If the end of the stream has been reached 714, the method 618 ends 716.

[0034] If the decision on whether or not to attempt upshift 710 is “no”, a decision about whether or not to downshift 712 is be made. In one embodiment, a trigger threshold Θ_{down} is defined in a manner analogous to Θ_{up} . If $\varphi_{current} > \Theta_{down}$ then the stream quality may be adequate, and the agent controller module 402 will not downshift 718 stream quality. However, if $\varphi_{current} \leq \Theta_{down}$, the agent controller module 402 will downshift 718 the stream quality. If the end of the stream has not been reached 714, the agent controller module 402 begins to request and receive 704 lower quality streamlets and the method 618 starts again. Of course, the above described equations and algorithms are illustrative only, and may be replaced by alternative streamlet monitoring solutions.

[0035] The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

[0036] What is claimed is:

1. An apparatus for adaptive-rate content streaming, the apparatus comprising:
 - an agent controller module configured to simultaneously request a plurality of streamlets;
 - the agent controller further configured to continuously monitor streamlet requests and accordingly request higher or lower quality streamlets; and
 - a staging module configured to stage streamlets and arrange the streamlets for playing on a content player.

2. A system for adaptive-rate content streaming, the system comprising:
 - a content server having a content module configured to process content and generate a plurality of high and low quality streams;
 - each of the high and low quality streams comprising a plurality of streamlets;
 - a client module configured to dynamically request high or low quality streams according to a performance factor;
 - the client module further comprising a streamlet cache configured to store streamlets; and
 - a content player configured to present media streams.

3. A computer readable storage medium comprising computer readable code configured to carry out a method for presenting rate-adaptive content streams, the method comprising:

requesting a plurality of streams of different qualities according to available resources;

automatically transmitting a plurality of streams according to user preferences;

remotely controlling playback of the stream;

fast starting a stream; and

presenting a plurality of content streams.

100

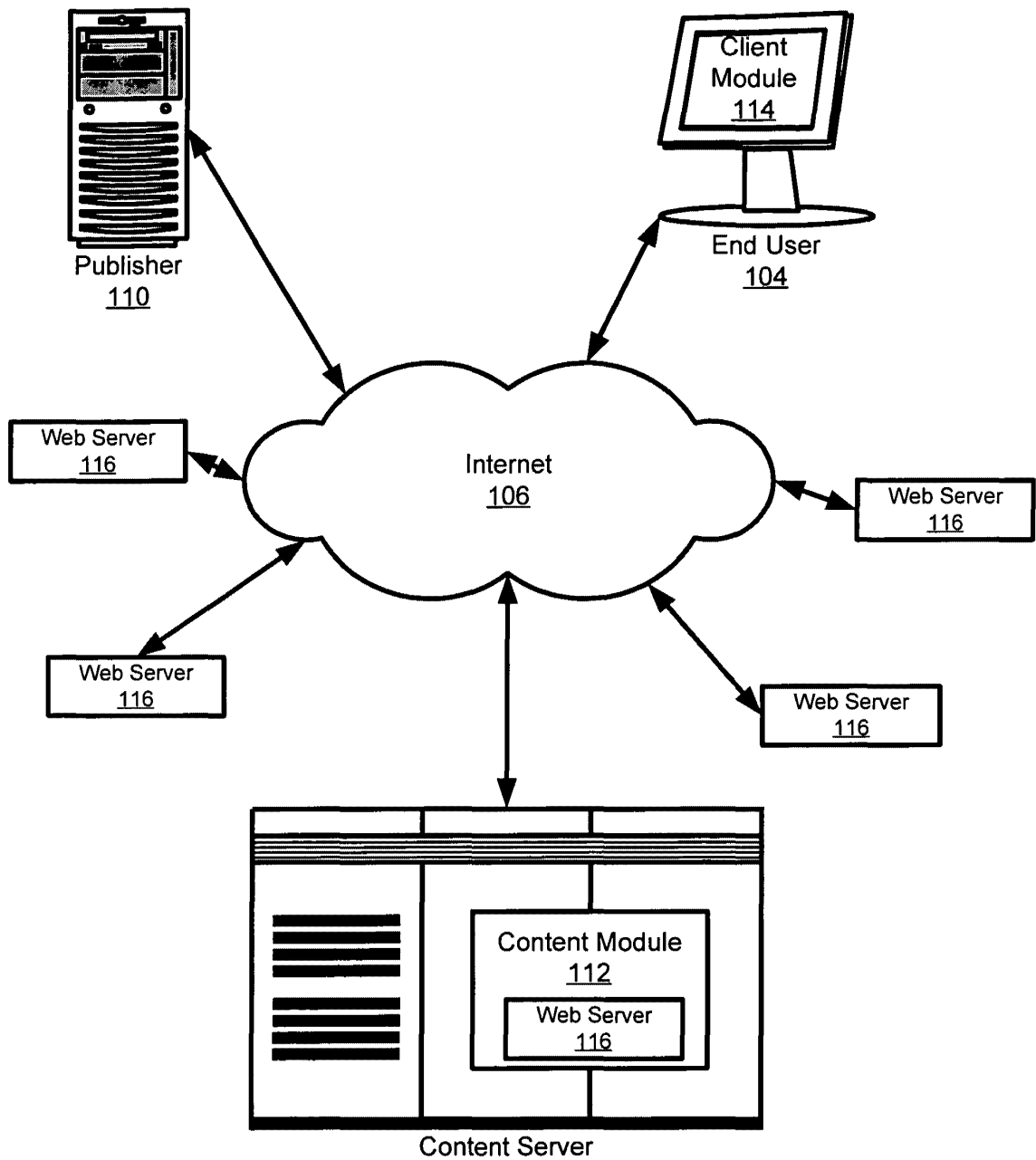


FIG. 1

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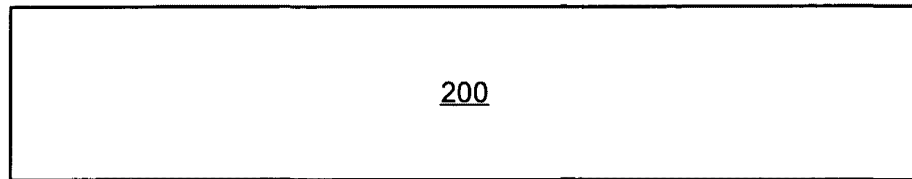


FIG. 2a

Playback Time Duration

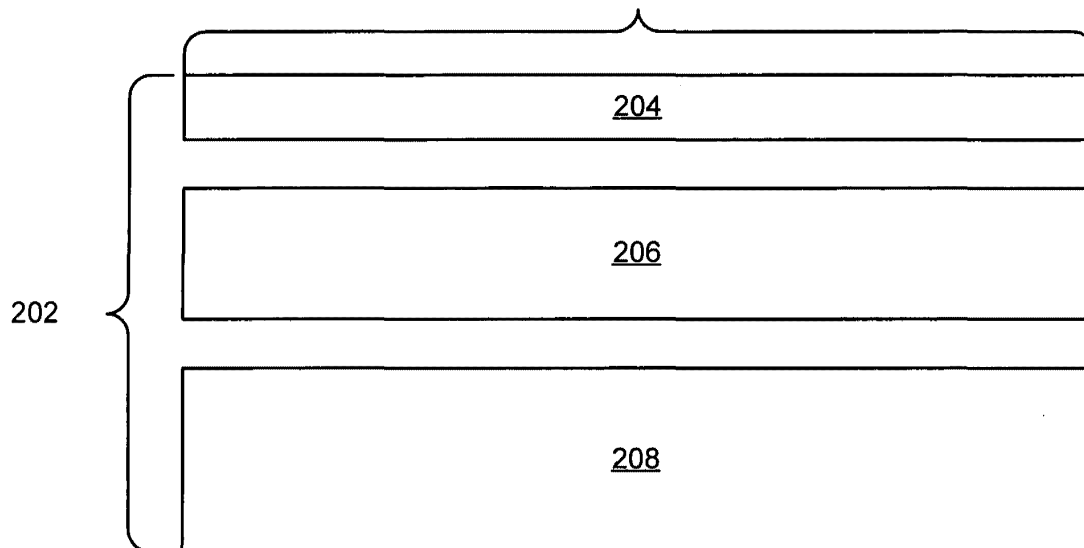


FIG. 2b

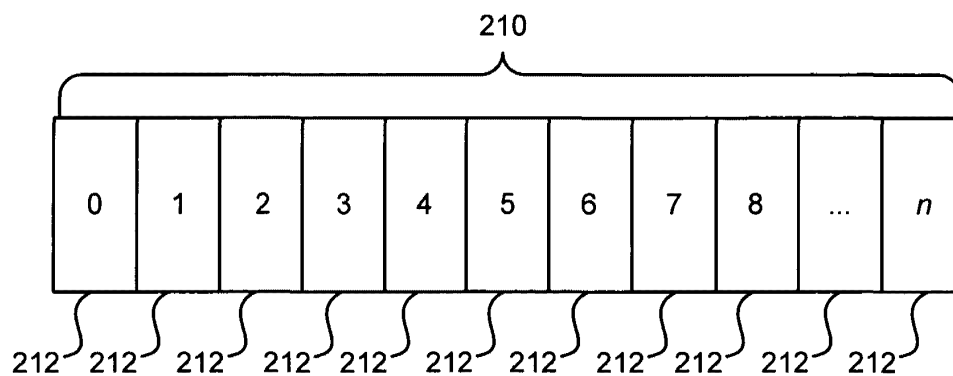


FIG. 2c

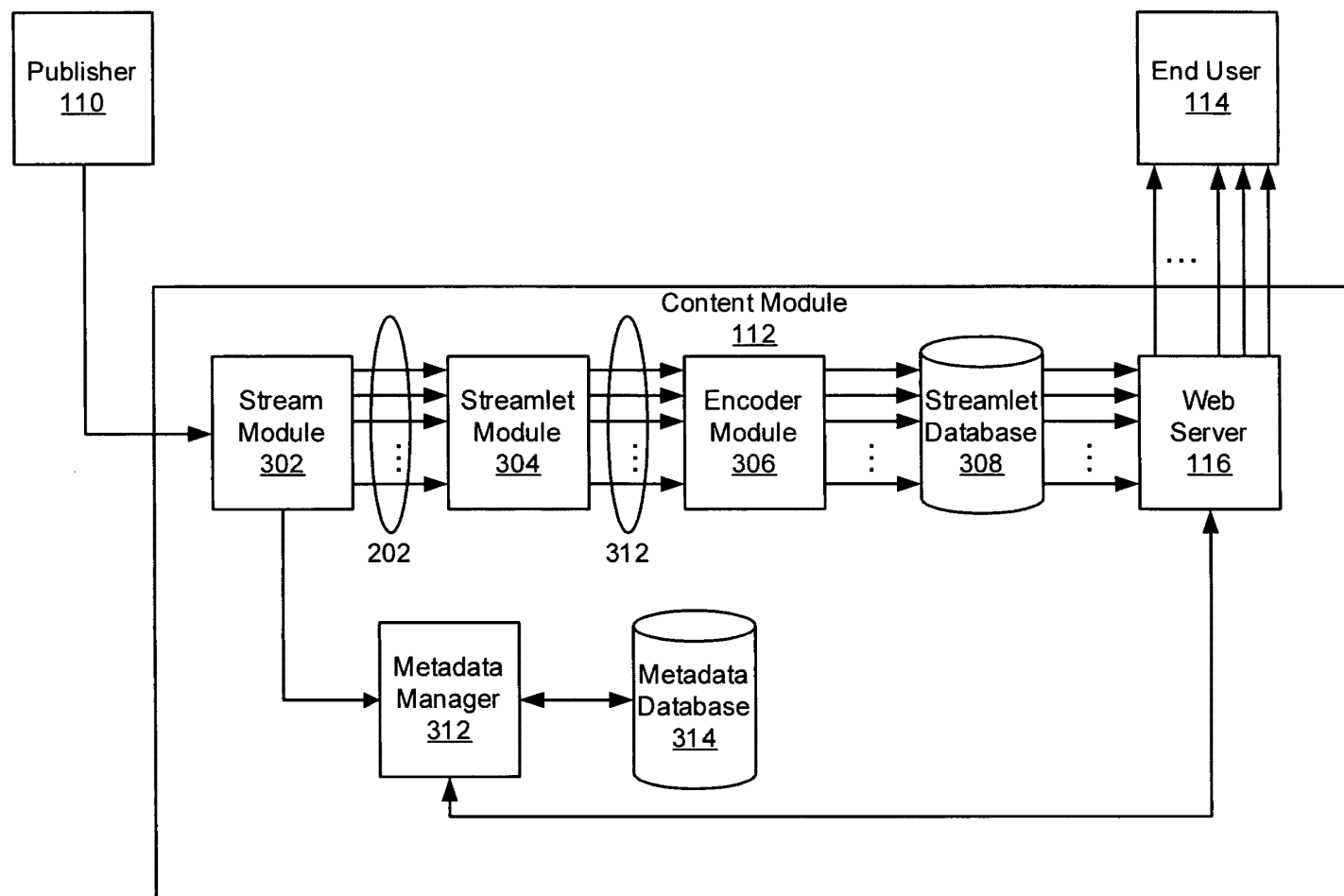


FIG. 3

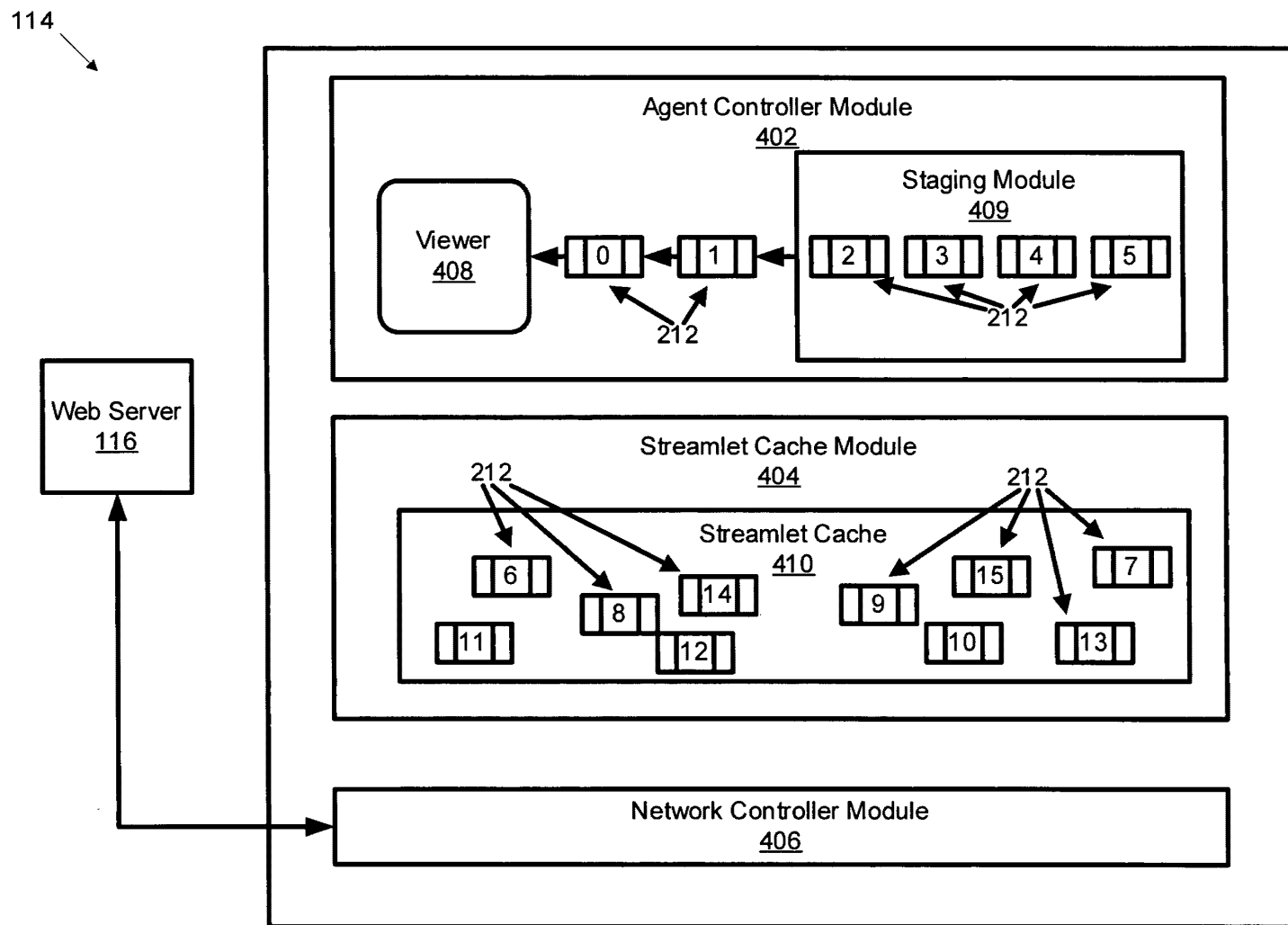


FIG. 4

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500 ↘

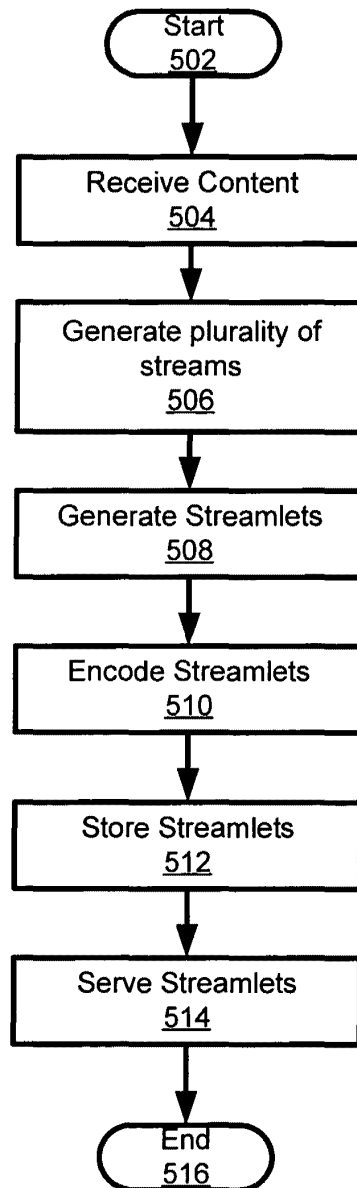


FIG. 5

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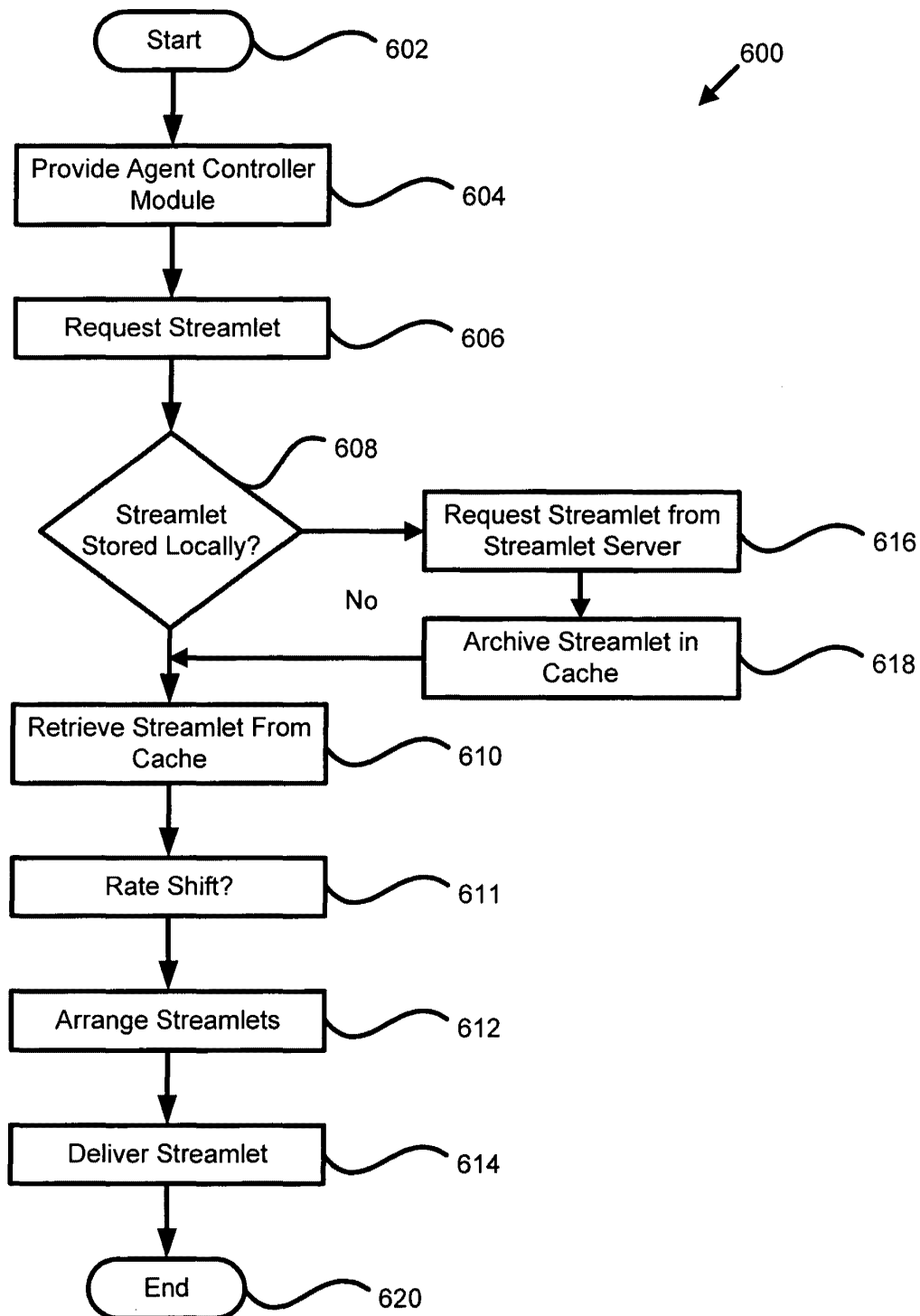


FIG. 6

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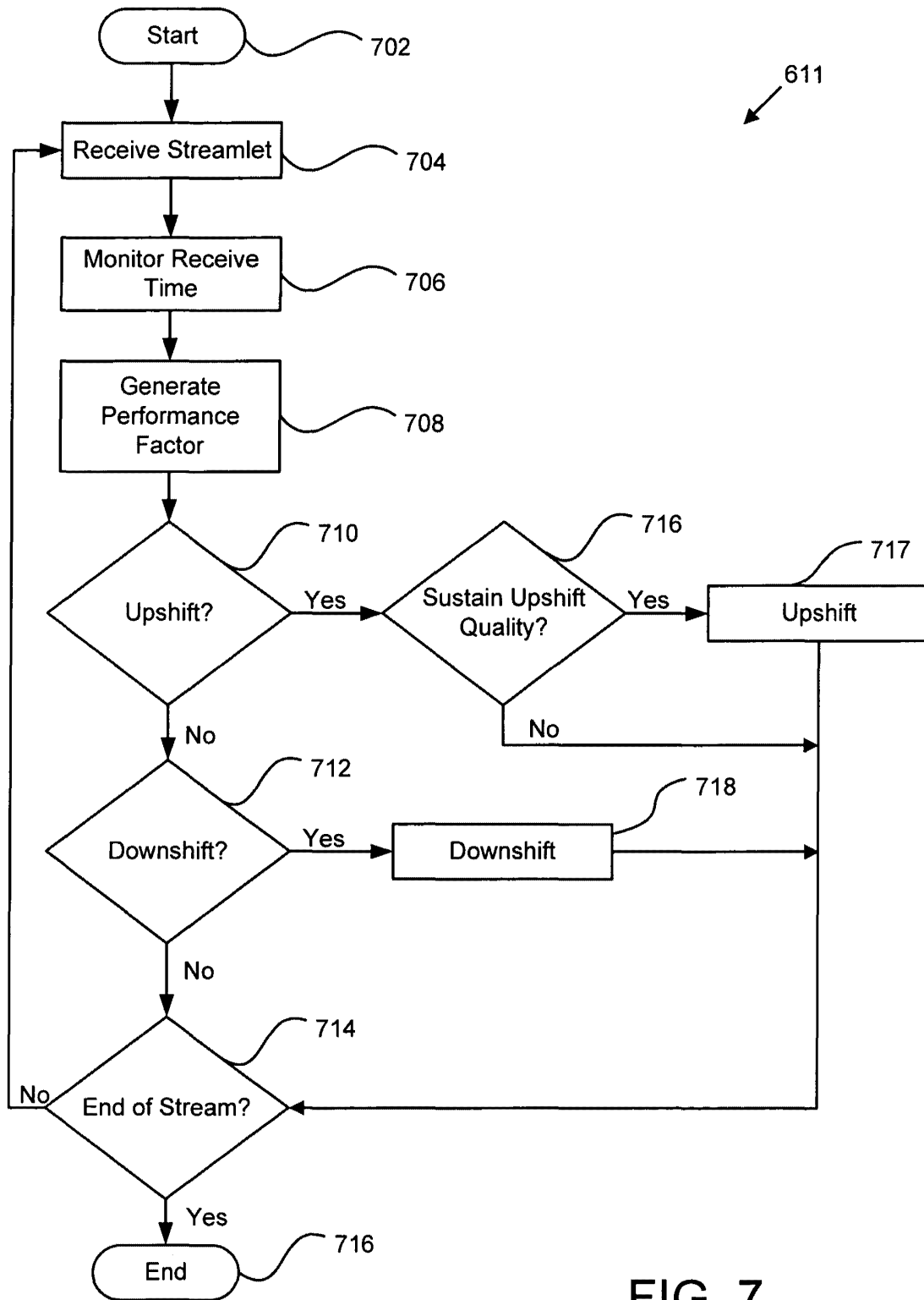


FIG. 7

PATENT APPLICATION SERIAL NO. _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

05/04/2004 JBALINAM 00000049 60566831

01 FC:2005

80.00 DP

PTO-1556
(5/87)

*U.S. Government Printing Office: 2002 — 489-287/69033

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I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(b).

I hereby appoint:



Practitioners associated with the Customer Number:

70560

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Practitioner(s) named below (If more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

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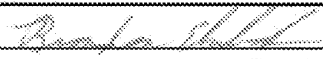
Assignee Name and Address:

EchoStar Advanced Technologies L.L.C.
100 Inverness Terrace East
Englewood, CO 80112

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature		Date	1/2/11
Name	Brandon Ehrhart	Telephone	720 514-5297
Title	Vice President, Associate General Counsel and Assistant Secretary		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by this public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: ECHOSTAR ADVANCED TECHNOLOGIES L.L.C.

Application No./Patent No.: 60/566,831

Filed/Issue Date: April 30, 2004

Titled: APPARATUS, SYSTEM, AND METHOD FOR DYNAMIC-RATE SHIFTING OF STREAMING CONTENT

ECHOSTAR ADVANCED TECHNOLOGIES L.L.C., a limited liability company

(Name of Assignee)

(Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that it is:

1. ☒ the assignee of the entire right, title, and interest in;
 2. ☐ an assignee of less than the entire right, title, and interest in
(The extent (by percentage) of its ownership interest is _____ %); or
 3. ☐ the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)
- the patent application/patent identified above, by virtue of either:

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy therefore is attached.

OR

B. ☒ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

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☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☐ As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

Signature

Max Gratton(Reg. No. 56,541)

Printed or Typed Name

1/12/11

Date

Corporate Counsel

Title

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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Electronic Acknowledgement Receipt	
EFS ID:	9244376
Application Number:	60566831
International Application Number:	
Confirmation Number:	8548
Title of Invention:	Apparatus, system, and method for dynamic rate shifting of streaming content
First Named Inventor/Applicant Name:	Robert D. Major
Correspondence Address:	Kunzler & Associates Suite 600 8 East Broadway - Salt Lake City UT 84111 US - -
Filer:	Brett Carlson/Sharron Castillo
Filer Authorized By:	Brett Carlson
Attorney Docket Number:	2082.2.1p
Receipt Date:	17-JAN-2011
Filing Date:	30-APR-2004
Time Stamp:	15:57:14
Application Type:	Provisional

Payment information:

Submitted with Payment	no
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File Listing:

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	20110117_POA.pdf	269859 5d9edaf1f3fde7448c8e084f21589a82a94ad775	no	1
Warnings:					
Information:					
2	Assignee showing of ownership per 37 CFR 3.73(b).	20110117_Stmt373b_60566831.pdf	274009 7f86a6e31dbc57df8a7cc78d4875e23a19073596	no	1
Warnings:					
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Total Files Size (in bytes):			543868		
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
60/566,831	04/30/2004	Robert D. Major	2082.2.1p

CONFIRMATION NO. 8548

POWER OF ATTORNEY NOTICE

Kunzler & Associates
Suite 600
8 East Broadway
Salt Lake City, UT 84111



Date Mailed: 01/26/2011

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 01/17/2011.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

/mnguyen/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101



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60/566,831	04/30/2004	Robert D. Major	2082.2.1p

CONFIRMATION NO. 8548

POA ACCEPTANCE LETTER

70560
INGRASSIA FISHER & LORENZ, P.C. (EchoStar)
7010 E. COCHISE ROAD
SCOTTSDALE, AZ 85253



Date Mailed: 01/26/2011

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

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