US 20100114816A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2010/0114816 A1**

Kiilerich (43) **Pub. Date: May 6, 2010**

(54) **TRANSCODE MATRIX**

(75) Inventor: **Dennis A. Kiilerich**, Kirkland, WA (US)

Correspondence Address:
LEE & HAYES, PLLC
601 W. RIVERSIDE AVENUE, SUITE 1400
SPOKANE, WA 99201 (US)

(73) Assignee: **Microsoft Corporation**, Redmond, WA (US)

(21) Appl. No.: **12/685,951**

(22) Filed: **Jan. 12, 2010**

Related U.S. Application Data

(63) Continuation of application No. 11/039,252, filed on Jan. 19, 2005, now Pat. No. 7,669,121.

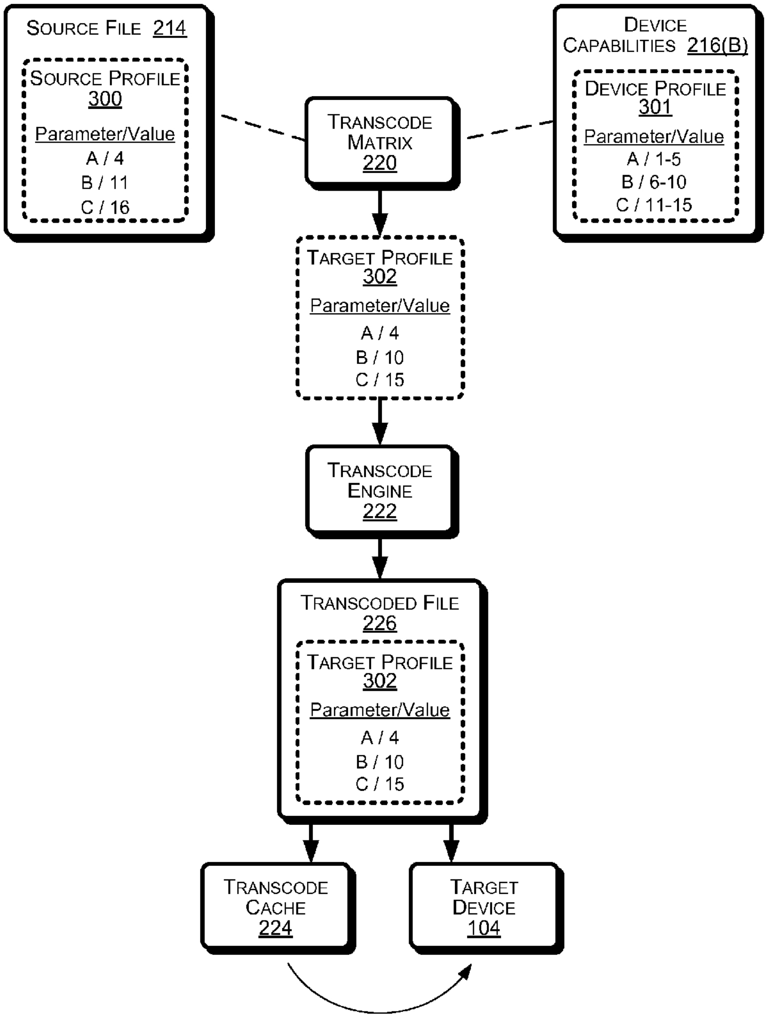
Publication Classification

(51) **Int. Cl.**
G06F 17/30 (2006.01)

(52) **U.S. Cl.** **707/610**; 707/E17.009

(57) **ABSTRACT**

A transcode architecture determines if a media source file needs to be transcoded for playback on a target playback device, and if so, the proper format needed for transcoding the source file. A transcode architecture includes a transcode manager, a transcode matrix, a transcode engine and a cache for storing transcoded media files. A media library stores media source files and device capabilities information. The transcode manager controls a transcode process in which the transcode matrix generates a profile for a media source file and accesses device capabilities that indicate playback capabilities for a target playback device. The transcode matrix compares parameters of the source profile with the device capabilities to decide whether the source file must be transcoded to enable playback of the file on the target playback device, and if so, the proper format needed for transcoding the source file.



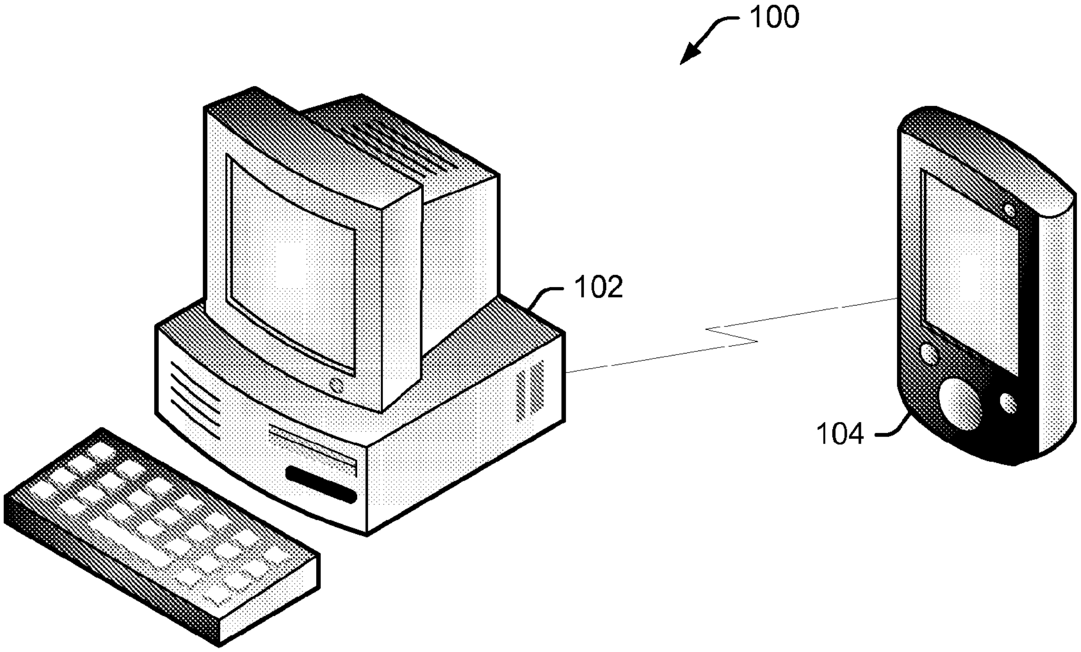


Fig. 1

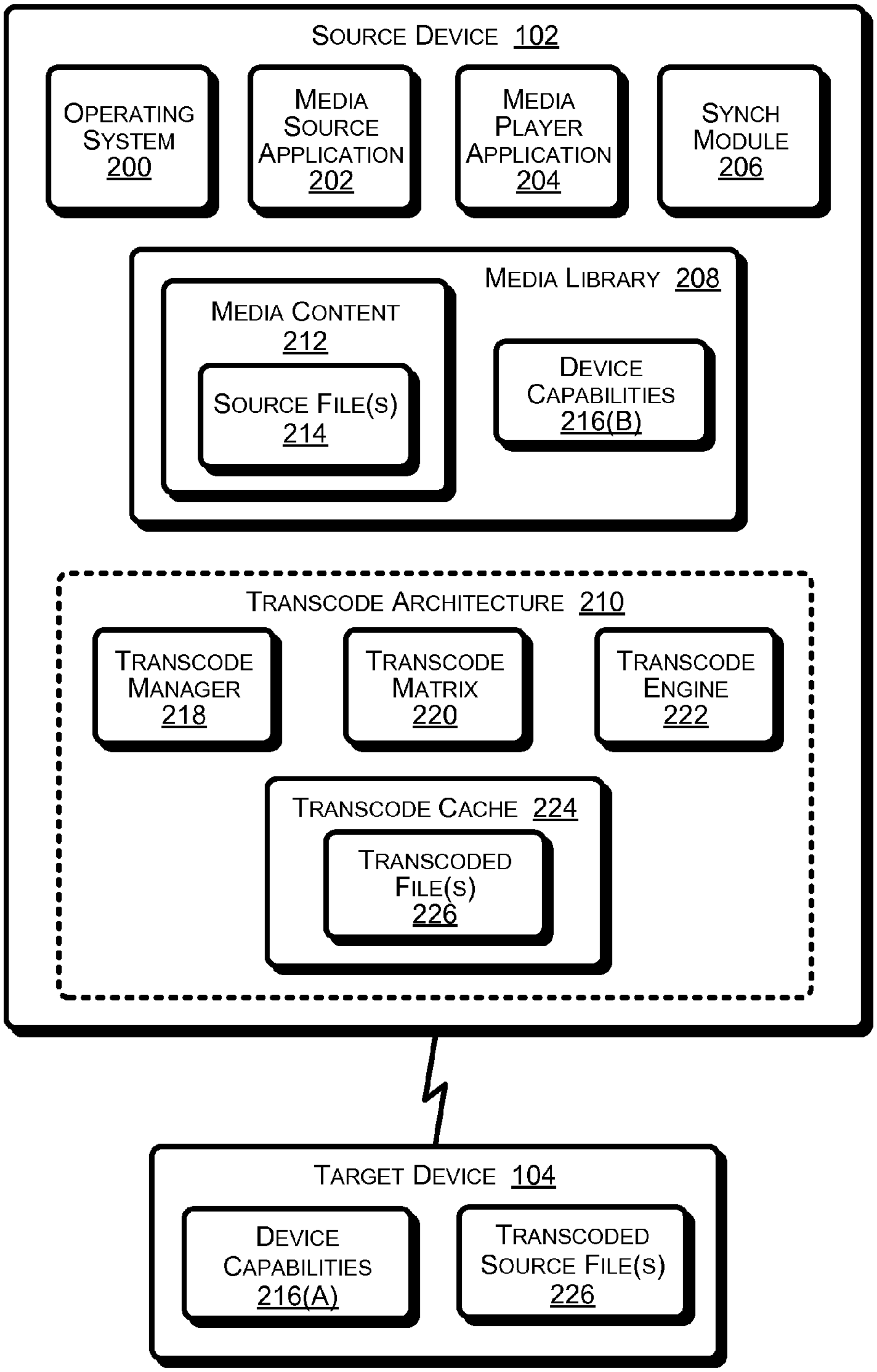

SOURCE DEVICE 102
OPERATING SYSTEM 200
MEDIA SOURCE APPLICATION 202
MEDIA PLAYER APPLICATION 204
SYNCH MODULE 206
MEDIA LIBRARY 208
MEDIA CONTENT 212
SOURCE FILE(S) 214
DEVICE CAPABILITIES 216(B)
TRANSCODE ARCHITECTURE 210
TRANSCODE MANAGER 218
TRANSCODE MATRIX 220
TRANSCODE ENGINE 222
TRANSCODE CACHE 224
TRANSCODED FILE(S) 226
TARGET DEVICE 104
DEVICE CAPABILITIES 216(A)
TRANSCODED SOURCE FILE(S) 226

Fig. 2

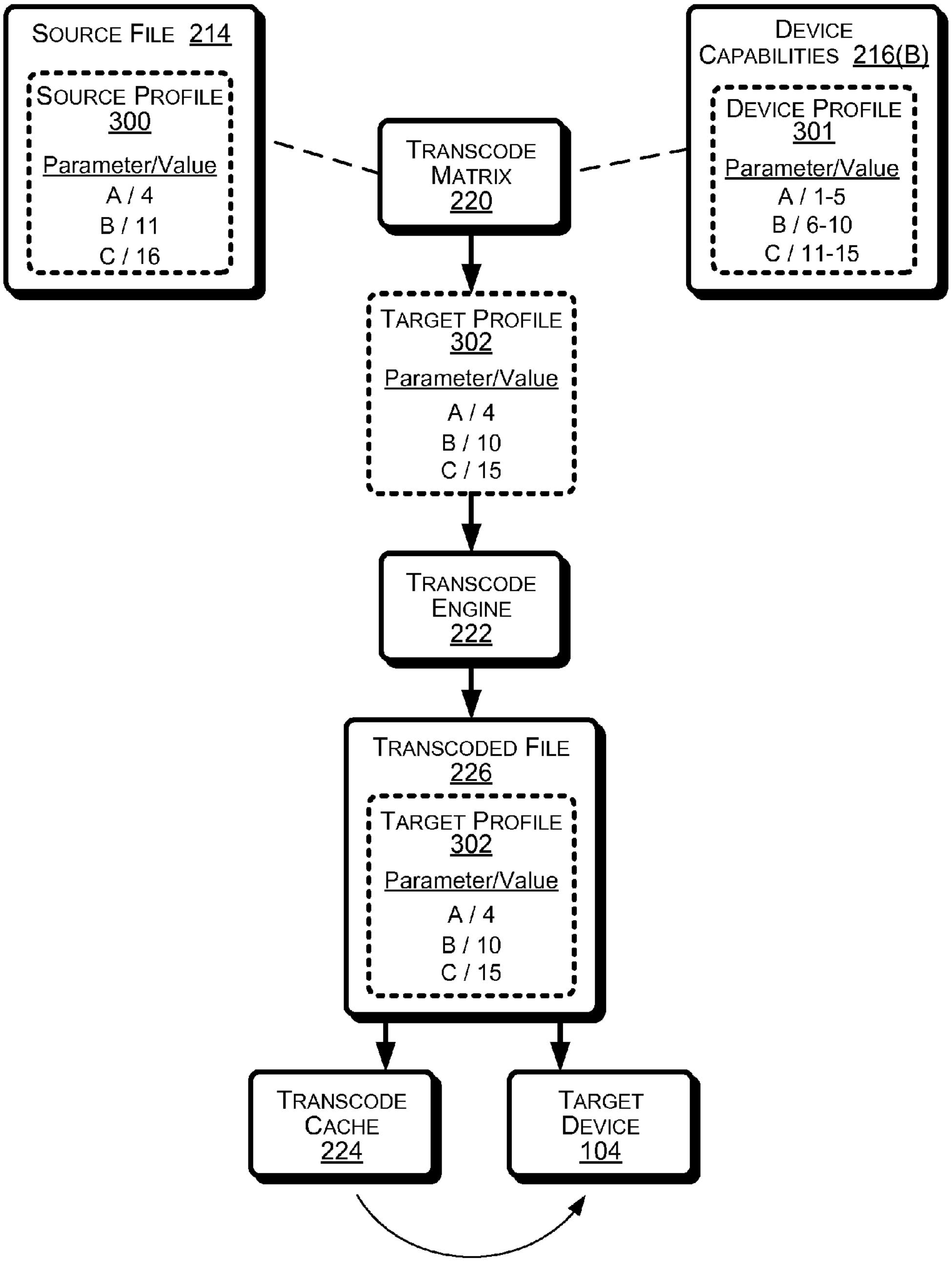

SOURCE FILE 214
SOURCE PROFILE 300
Parameter/Value
A / 4
B / 11
C / 16
TRANSCODE MATRIX 220
DEVICE CAPABILITIES 216(B)
DEVICE PROFILE 301
Parameter/Value
A / 1-5
B / 6-10
C / 11-15
TARGET PROFILE 302
Parameter/Value
A / 4
B / 10
C / 15
TRANSCODE ENGINE 222
TRANSCODED FILE 226
TARGET PROFILE 302
Parameter/Value
A / 4
B / 10
C / 15
TRANSCODE CACHE 224
TARGET DEVICE 104

Fig. 3

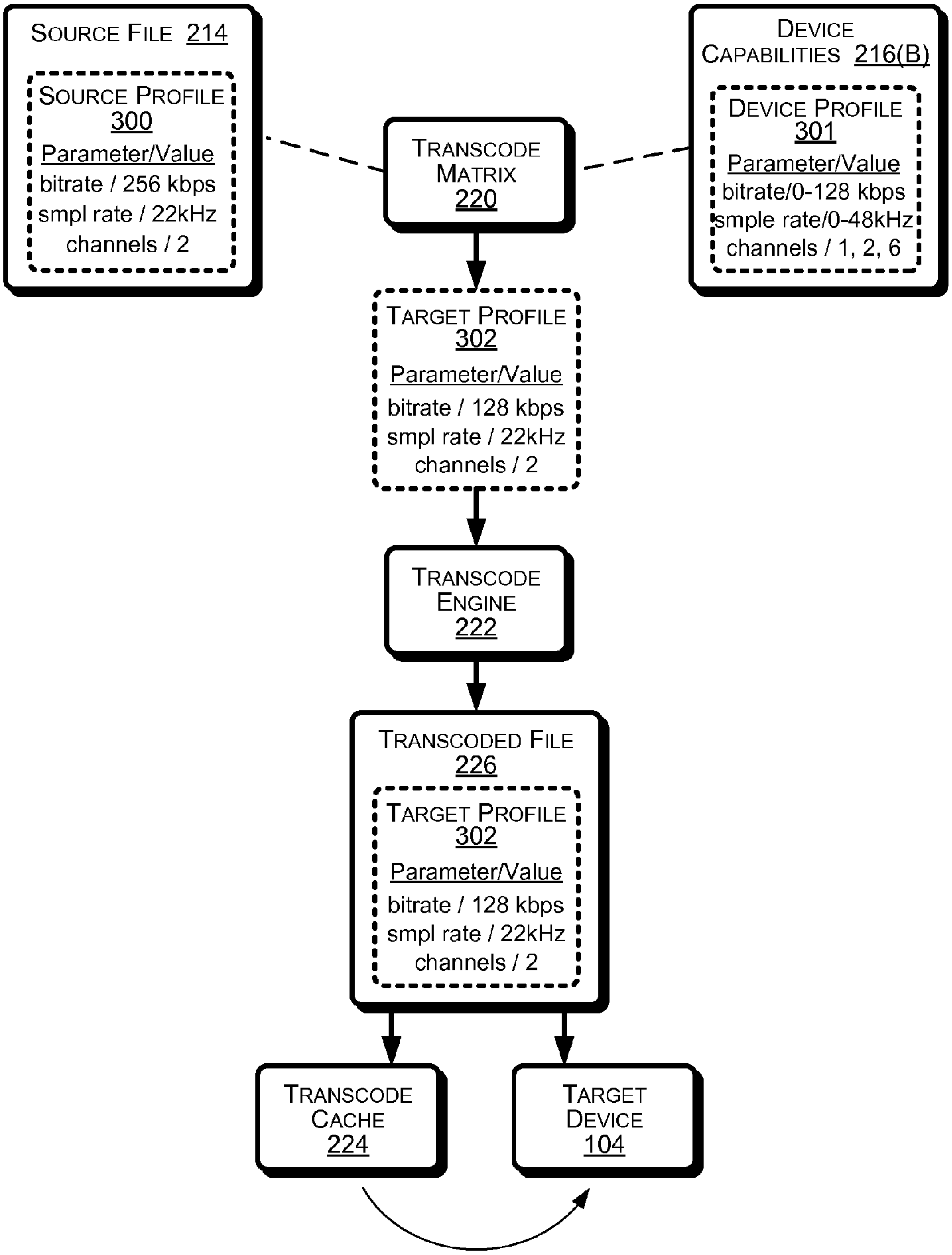

SOURCE FILE 214
SOURCE PROFILE 300
Parameter/Value
bitrate / 256 kbps
smpl rate / 22kHz
channels / 2
DEVICE CAPABILITIES 216(B)
DEVICE PROFILE 301
Parameter/Value
bitrate/0-128 kbps
smple rate/0-48kHz
channels / 1, 2, 6
TRANSCODE MATRIX 220
TARGET PROFILE 302
Parameter/Value
bitrate / 128 kbps
smpl rate / 22kHz
channels / 2
TRANSCODE ENGINE 222
TRANSCODED FILE 226
TARGET PROFILE 302
Parameter/Value
bitrate / 128 kbps
smpl rate / 22kHz
channels / 2
TRANSCODE CACHE 224
TARGET DEVICE 104

Fig. 4

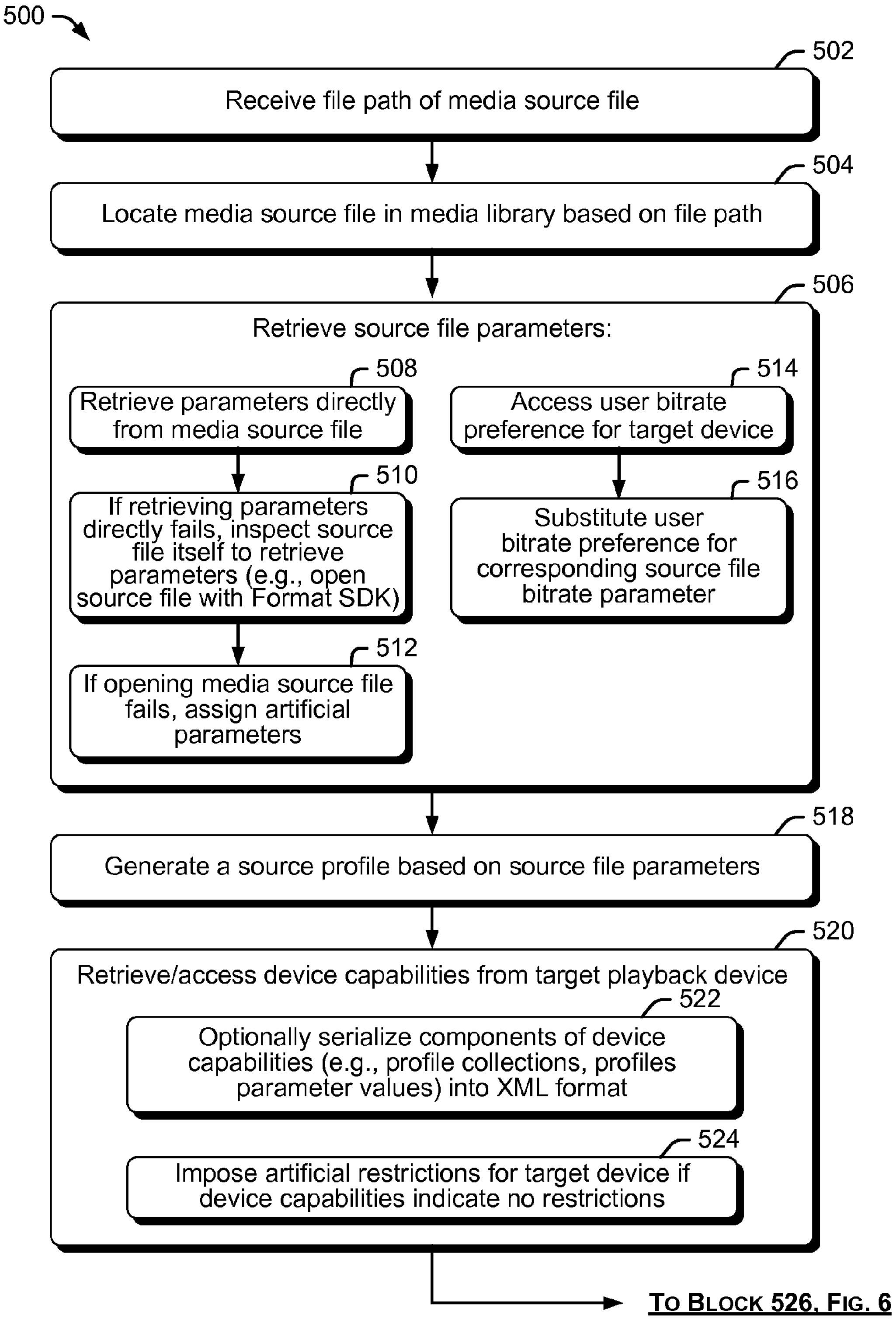

500
502
Receive file path of media source file
504
Locate media source file in media library based on file path
506
Retrieve source file parameters:
508
Retrieve parameters directly from media source file
510
If retrieving parameters directly fails, inspect source file itself to retrieve parameters (e.g., open source file with Format SDK)
512
If opening media source file fails, assign artificial parameters
514
Access user bitrate preference for target device
516
Substitute user bitrate preference for corresponding source file bitrate parameter
518
Generate a source profile based on source file parameters
520
Retrieve/access device capabilities from target playback device
522
Optionally serialize components of device capabilities (e.g., profile collections, profiles parameter values) into XML format
524
Impose artificial restrictions for target device if device capabilities indicate no restrictions
To Block 526, Fig. 6

Fig. 5

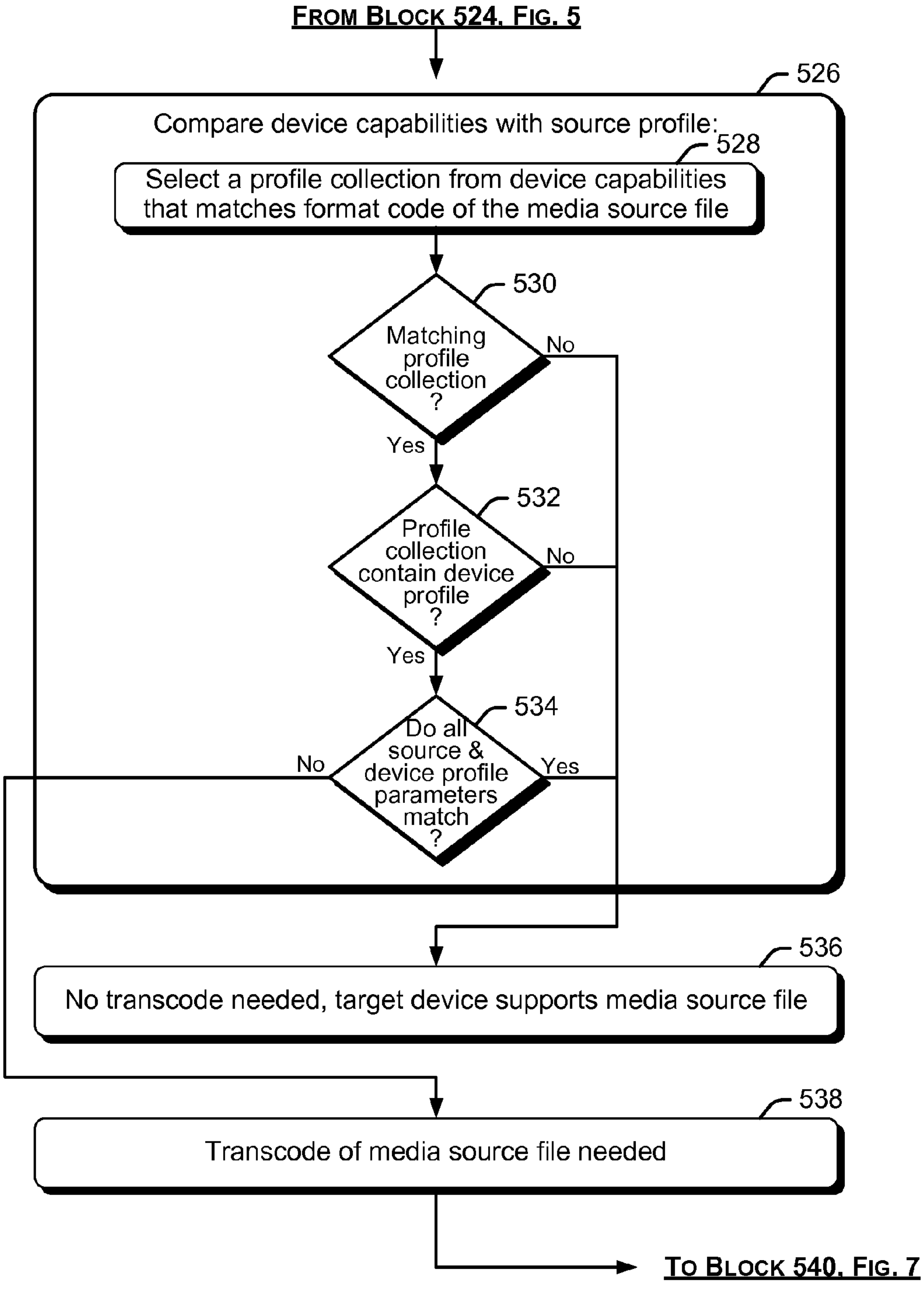

FROM BLOCK 524, FIG. 5
526
Compare device capabilities with source profile:
528
Select a profile collection from device capabilities that matches format code of the media source file
530
Matching profile collection ?
No
Yes
532
Profile collection contain device profile ?
No
Yes
534
Do all source & device profile parameters match ?
No
Yes
536
No transcode needed, target device supports media source file
538
Transcode of media source file needed
TO BLOCK 540, FIG. 7

Fig. 6

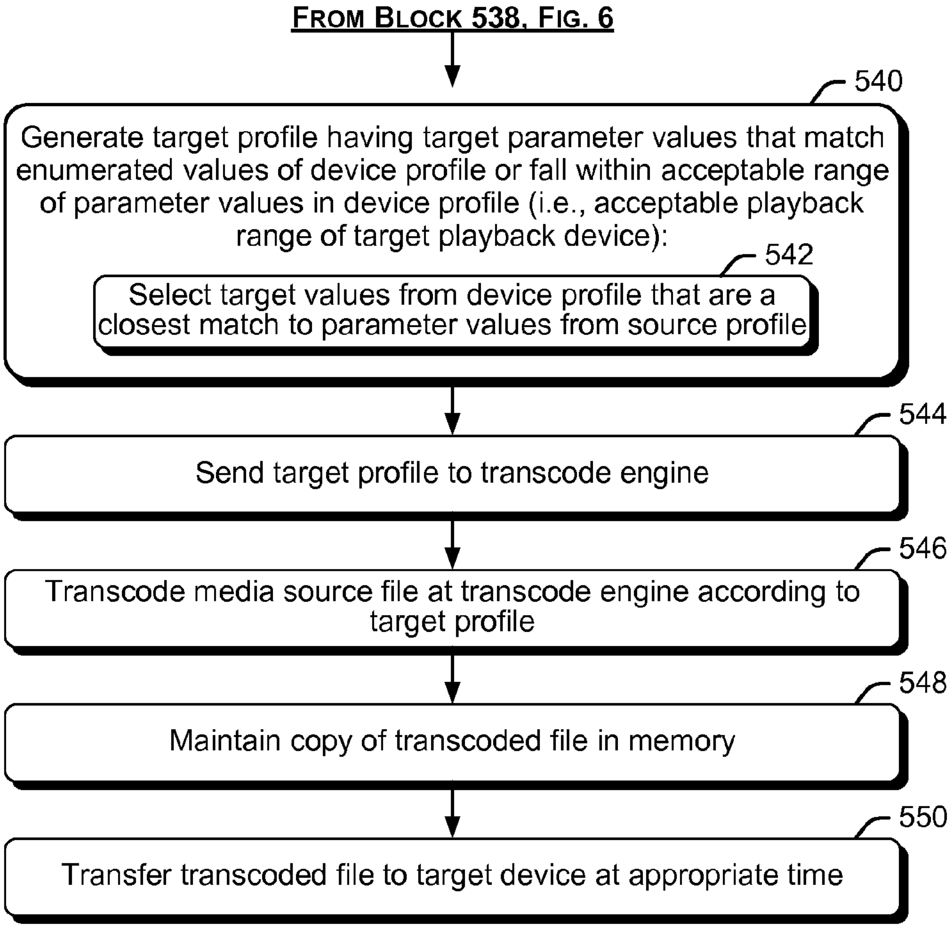

FROM BLOCK 538, FIG. 6
540
Generate target profile having target parameter values that match enumerated values of device profile or fall within acceptable range of parameter values in device profile (i.e., acceptable playback range of target playback device):
542
Select target values from device profile that are a closest match to parameter values from source profile
544
Send target profile to transcode engine
546
Transcode media source file at transcode engine according to target profile
548
Maintain copy of transcoded file in memory
550
Transfer transcoded file to target device at appropriate time

Fig. 7

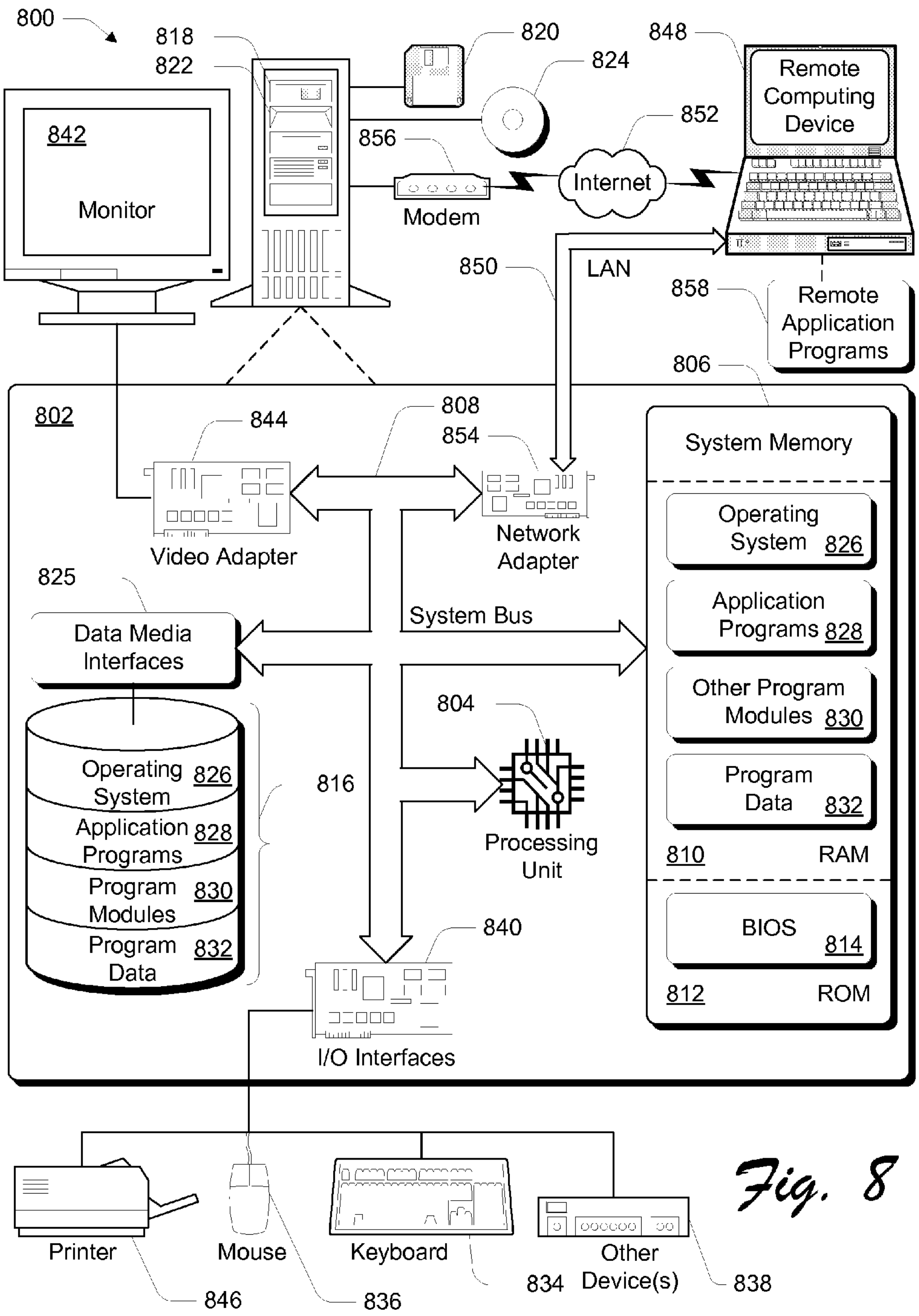

800
818
822
820
824
848
Remote Computing Device
842
Monitor
856
852
Modem
Internet
850
LAN
858
Remote Application Programs
806
802
844
808
854
Video Adapter
Network Adapter
System Memory
Operating System 826
Application Programs 828
Other Program Modules 830
Program Data 832
810 RAM
BIOS 814
812 ROM
825
Data Media Interfaces
System Bus
804
Processing Unit
816
Operating System 826
Application Programs 828
Program Modules 830
Program Data 832
840
I/O Interfaces
Printer
Mouse
Keyboard
Other Device(s)
846
836
834
838

Fig. 8

TRANSCODE MATRIX

PRIORITY CLAIM AND CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation of and claims priority to U.S. patent application Ser. No. 11/039,252, filed Jan. 19, 2005, the disclosure of which is incorporated by reference herein.

TECHNICAL FIELD

[0002] The present disclosure generally relates to synchronizing media content between a source device and a target playback device, and more particularly to determining a format for transcoding the media content if transcoding the media content is necessary for playback on the target device.

BACKGROUND

[0003] As digital media technology continues to advance and the cost of storage continues to decline, users increasingly host and consume digital media on their own primary computers (e.g., desktop PCs). Examples of such digital media include music, video, still pictures, and so on.

[0004] In addition, a corresponding increase in the availability of portable media playback devices such as personal digital assistants (PDAs), hand-held computers, laptop computers, and smart phones is providing users more ubiquitous access to information than ever. As users rely more and more on such portable devices, there is a growing need for applications that effectively transfer digital media from source devices, such as primary computers, to the portable playback devices.

[0005] Transcoding is a way of altering a media file through one or more transcoding processes so the file can be played back on a particular playback device. Thus, transcoding converts a source media file having certain characteristics into a target media file having different characteristics. Such transcoding processes can include, for example, converting a media file from one format to another (e.g., MP3 to WMA), changing the codec of the file, down-sampling the file to a lower bit rate to reduce the amount of storage space needed on the playback device, adapting the screen size of the file (i.e., height/width) so video appears correctly on the playback device, and so on.

[0006] Deciding whether a source media file needs to be transcoded for playback on a particular target playback device and what format to transcode the source file to based on the target playback device's capabilities are important steps in the transcoding process. That is, a source media file on a source device may be formatted correctly for playback on one target playback device, but may need to have one or more parameters reformatted before it can be played back on a different target playback device. There is a continual need to improve the transcoding process through such decision steps in order to ensure that source files are properly and timely transcoded for transfer and playback on different target playback devices.

SUMMARY

[0007] A system and methods are described for determining if a media source file needs to be transcoded for playback on a target playback device and, if so, the proper format needed for transcoding the source file. The source file can then be transcoded and transferred to the target playback device.

[0008] In a described embodiment, a system provides a transcode architecture that includes a transcode manager, a transcode matrix, a transcode engine and a cache for storing transcoded media files. The system also includes a media library to store media source files and device capabilities information. In the described embodiment, the transcode manager controls a transcode process in which the transcode matrix generates a profile for a media source file and accesses device capabilities that indicate playback capabilities for a target playback device. The transcode matrix compares parameters of the source profile with the device capabilities to decide whether the source file must be transcoded to enable playback of the file on the target playback device. If the source file needs to be transcoded, the transcode matrix generates a target profile containing target parameters determined to match, and/or fall within acceptable ranges of, corresponding parameters indicated in the device capabilities. The transcode matrix hands off the target profile to the transcode engine, which transcodes the source file according to the target profile. The transcoded source file is then saved in a memory and can be transferred to the target playback device at an appropriate time, such as when the target playback device is connected to the source device during a synchronization process.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The same reference numerals are used throughout the drawings to reference like components and features.

[0010] FIG. **1** illustrates an exemplary environment suitable for determining if a media source file needs to be transcoded for playback on a target playback device and, if so, the proper format needed for transcoding the source file.

[0011] FIG. **2** illustrates a block diagram representation of an exemplary source device that is suitable for determining if a media source file needs to be transcoded for playback on a target playback device and, if so, the proper format needed for transcoding the source file.

[0012] FIG. **3** illustrates a block diagram representation of an exemplary process for comparing a source profile with the device capabilities of a target playback device to determine if a source file needs to be transcoded, and how various parameters of the source file should be transcoded if necessary.

[0013] FIG. **4** illustrates a block diagram representation of an exemplary process as shown in FIG. **3** using exemplary parameters that illustrate how a transcode matrix determines target values for a target profile.

[0014] FIGS. **5-7** are a flow diagram illustrating exemplary methods for determining if a media source file needs to be transcoded for playback on a target playback device and, if so, the proper format needed for transcoding the source file for background transcoding.

[0015] FIG. **8** illustrates an exemplary computing environment suitable for implementing a source computing device such as discussed with reference to FIGS. **1** through **4**.

DETAILED DESCRIPTION

Introduction

[0016] The following discussion is directed to a system and methods for determining whether a media source file needs to be transcoded to enable playback of the file on a target playback device, and the manner in which such transcoding will be implemented with respect to various parameters of the source file. The system and methods described herein for determining the transcoding requirements of a source media file to play back on a target playback device, facilitate and improve transcoding in general, regardless of whether the transcoding is performed before or during transferring/synchronizing of the media file to the target playback device.

Exemplary Environment

[0017] FIG. **1** illustrates an exemplary environment **100** suitable for determining whether a digital media source file needs to be transcoded and what format the file should be transcoded to if needed. The exemplary environment **100** generally illustrates a media content synchronization scenario in which a target playback device **104** is coupled to a source device **102** for the purpose of transferring pre-transcoded media content from the source device to the target device. In a typical scenario, media content received by source device **102** and destined for synchronization with a target playback device **104** is fully transcoded prior to the time the target device **104** is connected to the source device. Thus, copying media content from the source device **102** to the target playback device **104** is uninhibited by the transcoding process, and the time for synchronizing/copying the content is significantly reduced.

[0018] It is noted that the hardwire coupling between the source device **102** and target playback device **104** as shown in the exemplary environment **100** of FIG. **1** is intended by way of example only, and not by way of limitation, to illustrate one manner of facilitating content synchronization/transfer from source device **102** to target playback device **104**. Various other known methods for coupling the target playback device **104** for synchronization are also contemplated, including for example, coupling through a synchronization port that includes a docking cradle for the playback device **104**, coupling through a wireless infrared port, coupling via a network using a wireless and/or modem/cellular-based Internet and VPN (virtual private network), and so on. Thus, physical coupling of target playback device **104** to source device **102** for content synchronization is not necessary.

[0019] Source computing device **102** is typically implemented as a user's primary computing device, such as a desktop personal computer (PC). However, source device **102** might also be implemented as various other conventional computing devices generally configured to receive and render multi-media content from various sources, and/or to reformat such content for synchronization and playback on a target playback device **104**. An example of a source computing device **102** is depicted in FIG. **8** and described in greater detail below in the Exemplary Computing Environment section.

[0020] Target media playback device **104** may be implemented as any one of numerous digital media player devices available from various manufacturers, a general computing device such as a desktop PC, or any other suitable media playback device. Such devices are typically configured with audio and/or video subsystems capable of rendering digital media (audio/video) files such as MP3 (MPEG-1 Audio Layer 3) files, .WAV (Windows® Wave) files, .WMA (Windows® Media Audio) files, .WMV (Windows® Media Video) files, MPEG (Moving Picture Experts Group) files, .jpg files, .gif files, and the like. Accordingly, by way of example and not limitation, a target media playback device **104** may include various general-purpose laptop and notebook computers configured to playback media content, in addition to devices that are more specifically designed to play back various forms of multimedia, such as Rio's Rio Riot and Rio Karma, Archos' Jukebox Recorder 20 and AV320 Pocket Audio/Video Recorder, Creative's Jukebox Zen and Portable Media Center Zen, Apple's iPod, ZVUE's MP4 Video Player, and so on.

Exemplary Embodiments

[0021] FIG. **2** illustrates a block diagram representation of an exemplary source device **102** that is suitable for determining whether a media source file needs to be transcoded for playback on a target playback device **104**, and the manner in which various parameters of the source file should be transcoded if necessary. Various components of source device **102** facilitate the retrieval and management of media content for the general purpose of rendering the content on source device **102** and/or synchronizing the content with target playback device **104**. These components include an operating system **200**, one or more media source applications **202**, a media player application **204**, a media content synchronization program module **206**, a media library **208**, and a transcode architecture **210** embodied on one or more processor-readable media (see FIG. **8** and Exemplary Computing Environment section below). Although these components are illustrated separately on source device **102**, it is noted that any one or more of these components may be implemented on source device **102** as part of a multimedia software product, the operating system **200**, or as stand-alone components.

[0022] A media source application **202** may be one or more of various applications and/or tools configured to receive media content. For example, media source application **202** may be an interactive TV service application that facilitates the recording of video (e.g., TV programming) directly off of a cable and/or satellite feed, a video capture component to transfer home video footage from a digital video recorder onto source device **102**, a Web browser application that facilitates downloading media off the Internet, and so on. Such media source applications **202** typically supply various forms of media content **212** to media library **208** on source device **102**. Thus, source files **214** within media content **212** stored in media library **208** may include, for example, audio files in the form of MP3 and WMA files, video files in the form of DVR-MS, AVI and MOV files, image files in the form of GIF and JPEG files, and so on. Media library **208** additionally includes device capabilities **216**(B) acquired from a target playback device **104** as discussed in greater detail herein below.

[0023] In addition to the configurations noted above, a media source application **202** may also include or be part of a media player application **204**. A media player application **204** is typically a desktop based application player that manages a broad range of multimedia related tasks. For example, a media player application **204** may handle streaming audio and video, CD/DVD playback, MP3 and WMA support, encoding, CD/DVD burning, Internet radio, and the like. A media player application **204** may also offer Web browser integration so it can be embedded in a browser enabling multi-tasking during streaming video. Like other media source applications **202**, a media player application **204** may supply various forms of media content **212** (i.e., source files **214** as audio files, video files, image files, etc.) to a media library **208** on source device **102**.

[0024] Synch module **206** may be configured as part of a media player application **204**, the operating system **200**, or as a stand-alone component, and provides a user-configurable model for facilitating the transfer of media source files **214** to a target playback device **104** from the media library **208** on source device **102**. As noted above, examples of media content **212** stored in media library **208** may include source files **214** in the form of audio, video, text, or image files. Media content **212** may also include a static or automated playlist of files (e.g., audio, video, and images) or any grouping of files or data. Some source files **214** in the media library **208** may be more or less important to a user than others, and the synch module **206** may assign a transfer priority to files in the library to indicate their relative importance or desirability as indicated by the user.

[0025] Components of transcode architecture **210** interact with synch module **206** and other components of source device **102** to facilitate transcoding of source files **214** (i.e., media content **212**). The transcoding of source files **214** is preferably performed as a background process on source device **102** in anticipation of a synchronization process that transfers media content to a target device **104** when the target device **104** is coupled to the source device **102**. However, transcoding may also be performed concurrently with such a synchronization process during the transfer of media content to a target device **104**.

[0026] Transcoding is generally managed by the transcode architecture **210**, which includes transcode manager **218**, transcode matrix **220**, transcode engine **222**, and a transcode cache **224** for storing transcoded media content (i.e., transcoded source files **226**). Transcode manager **218** retrieves device capabilities **216**(A) from a target device **104** (e.g., by querying the target device) upon an initial coupling of the target device **104** with source device **102**. Device capabilities **216** are an object or report from the target device **104** regarding what types of media content the device can play back successfully. A device capabilities **216** object or report contains a list of profile collections keyed by a format code. The format code is an indicator of content format loosely based on the extension of the file. A profile collection is a collection of profiles all having the same format code. A profile, in general, represents a type of file, either as source content or as content that a target device can play. Therefore, source profiles and device profiles are discussed throughout this disclosure. A profile includes codec information, and various content parameters such as bitrates, sample rates, number of channels, and so on. The parameter values in a profile are keyed by parameter name and they can be enumerated, ranged, or unrestricted.

[0027] Once device capabilities **216**(A) are retrieved by transcode manager **218**, they may be serialized into XML format and saved as device capabilities **216**(B) in the media library **208** in a row that represents that particular target device **104**. In addition, each component of the device capabilities **216** (i.e., including the profile collection, device profiles, and parameter values) may be serialized by itself, resulting in a combined XML. Sample device capabilities and sample serialized device capabilities are shown below in the Appendix section of this disclosure. The samples in the Appendix provide examples of device capabilities for a particular target playback device **104** and examples of what serialized device capabilities may look like.

[0028] The transcode manager **218** caches device capabilities **216**(B) in media library **208** so that they are accessible by transcode matrix **220** and other applications. In general, caching device capabilities **216**(B) enables the transcode architecture **210** to perform background transcoding of newly acquired media source files **214** (e.g., video/TV files, audio files) that match a target playback device's synchronization rules, even when the target device is not coupled to source device **102**. This minimizes the delay incurred at transfer time since source files **214** can be transcoded ahead of time. Transcode manager **218** monitors the media content **212** in the media library **208** for newly acquired media source files **214**. When a media source file **214** is stored in the media library **208** (e.g., by a media source application **202**, media player application **204**, etc.), the transcode manager **218** determines if the media source file **214** is destined to be transferred to a target device **104**. If so, the transcode manager **218** hands the source file path (i.e., location of source file within media library **208**) to the transcode matrix **220** and asks the transcode matrix **220** to determine whether the media source file **214** needs to be transcoded for playback on the target playback device **104**, and if so, how the source file **214** should be transcoded.

[0029] In order to determine if a media source file **214** needs to be transcoded for a particular target playback device **104**, the transcode matrix **220** first generates a source profile for the source file **214** that catalogues source file information such as the source file codec, parameters and their values, and so on. For an audio source file **214**, the parameters in the source profile typically include an audio bitrate, a sample rate, the number of channels, the audio bit depth, and the audio codec (e.g., WAVE codec). For a video source file **214**, the parameters in the source profile typically include a video bitrate, a height, a width, a frame rate, and the video codec (e.g., FOURCC codec). The transcode matrix **220** searches for the parameters of the source file **214** in the media library, according to the file path provided by transcode manager **218**. If this search fails, the transcode matrix **220** inspects the source file itself, for example, by opening the source file using a file format SDK to gain access to the source file parameters. If this also fails, the transcode matrix **220** will assign an artificial profile to the source file **214**. After accessing the source file parameters, the transcode matrix **220** generates the source profile for the source file. The transcode matrix **220** can then use the source profile for comparison with the device capabilities **216**(B) of a target playback device as discussed below with reference to FIG. **3**.

[0030] FIG. **3** illustrates a block diagram representation of an exemplary process for comparing a source profile **300** with the device capabilities **216**(B) of a target playback device **104** in order to determine if a source file **214** needs to be transcoded, and how various parameters of the source file should be transcoded if necessary. In FIG. **3**, a source file **214** is shown with its corresponding source profile **300** generated by transcode matrix **220** as discussed above. It is noted that source profile **300** is illustrated in FIG. **3** as a part of source file **214** only for the purpose of this discussion, to indicate that a source profile **300** is an inherent part of a source file **214**. However, after its generation by transcode matrix **220**, as discussed above, a source profile **300** may actually be stored in media library **208** or in some other memory on source device **102**.

[0031] There are several steps the transcode matrix **220** takes to determine if a source file **214** needs to be transcoded. The first is selecting a profile collection in the device capabilities **216**(B) that matches the format code of the source profile **300**. As noted above, a profile collection is a collection of device profiles that all have the same format code. The format code is an indicator of file content format that is loosely based on the file extension. For example, a format code for a WMA file will be selected from the device capabilities **216**(B) (assuming it exists in the device capabilities **216**(B)) if the source profile **300** is associated with a WMA source file. If a profile collection is not found in the device capabilities **216**(B) that matches the format code of the source profile **300**, then the source profile **300** is not supported, and the source file **214** is not playable on the target playback device **104**. Therefore, no transcode of the source file **214** would be necessary.

[0032] In the case where a profile collection is found in the device capabilities **216**(B) that does not contain any device profiles **301**, then the format code is supported with no restrictions, and the source file **214** also does not need to be transcoded. In this case, however, where a target device **104** does not specify any restrictions in its device capabilities **216**(B), artificial restrictions will be imposed while the device capabilities are being retrieved. For example, a 32-160 kbps (kilobits per second) bitrate and 0-44 KHz sample rate may be imposed on the target device **104**.

[0033] In the case where a profile collection is found in the device capabilities **216**(B) that contains one or more device profiles **301**, then the transcode matrix **220** determines if the source file **214** needs to be transcoded by checking each device profile **301** to see if it matches the source profile **300**. Matching is done by comparing each parameter in the source profile **300** with the corresponding parameter found in the device profile **301** of the device capabilities **216**(B). FIG. **3** shows the transcode matrix **220** making comparisons between example parameter values in a source profile **300** and corresponding parameter values in the device profile **301** of device capabilities **216**(B) (i.e., parameters A, B, and C). If a source profile parameter matches an enumerated value of the corresponding parameter in the device profile **301** of the device capabilities **216**(B), or if it falls into the range specified by the same parameter in the device profile **301**, then there is a match. If all parameters match between the source profile **300** and the device profile **301**, then the transcode matrix **220** determines that the target device **104** supports the source profile **300**. In this case, the transcode matrix **220** again concludes that there is no need to transcode the source file **214** because the source file **214** can be played back on the target device **104** in its current format.

[0034] However, if there are one or more parameters from the source profile **300** that do not match the corresponding parameters in the device profile **301** of the device capabilities **216**(B), then the transcode matrix **220** determines that the source file **214** needs to be transcoded. As discussed in more detail below, there are other scenarios in which the transcode matrix **220** may also determine that a source file **214** needs to be transcoded, such as when a user specifies a preference or when a device has a total bitrate restriction.

[0035] As shown in FIG. **3**, if the transcode matrix **220** determines that the source file **214** needs to be transcoded, it normalizes the source profile **300** by generating a target profile **302** based on the comparison of parameters between the source profile **300** and the device profile **301** of the device capabilities **216**(B). In general, a profile containing ranged or enumerated parameters (e.g., from device capabilities **216** can be normalized to a profile that has unique parameters by achieving a closest parameter match. For each parameter, therefore, the transcode matrix **220** determines a target value for the target profile **302** by comparing each parameter from the source profile **300** with its corresponding parameter in the device profile **301**. If a source profile **300** parameter value matches that of the device profile **301** (i.e., is the same as or within the same range as), then the transcode matrix **220** will set the target profile **302** parameter value to be the same as the source profile parameter value, which will be a single-valued enumeration containing this value. That is, if the source profile parameter and the device profile parameter match, the source profile parameter is not changed, but remains the same in the target profile **302**. FIG. **3** provides an example of this with parameter A. The value of parameter A in the source profile **300** is 4, while the acceptable range for parameter A in the device profile **301** is 1-5. Therefore, because parameter A falls within the acceptable range in the device capabilities **216**(B), the transcode matrix **220** sets the target value to 4 for parameter A in the target profile **302**.

[0036] If a source profile **300** parameter value does not match that of the device profile **301** in the device capabilities **216**(B) (i.e., is not the same as or within the same range as), then the transcode matrix **220** sets the target profile **302** parameter value to a value that is as close as possible to the source profile **300** parameter value while also being within the acceptable range for the device capabilities **216**(B). Referring to the FIG. **3** example, parameter B of the source profile **300** is 11, while the acceptable range for parameter B in the device profile **301** of the device capabilities **216**(B) is 6-10. As shown in the target profile **302**, the transcode matrix **220** sets the target value for parameter B to 10, which is the closest possible value to the source profile value of parameter B, while still being within the acceptable device capabilities range for parameter B. The case is similar for parameter C shown in FIG. **3**.

[0037] After generating the target profile **302**, the transcode matrix **220** hands off the target profile **302** to the transcode engine **222**. As shown in FIG. **3**, the transcode engine **222** transcodes the source file **214** in accordance with target parameter values within the target profile **302**. The transcode engine **222** generates a transcoded source file **304** whose parameters match those of the target profile **302**. Therefore, the transcoded file **304** in FIG. **3** is illustrated as containing the target profile **302**.

[0038] After the source file **214** is transcoded, the transcoded file **304** is typically stored on source device **102** in a transcode cache **224** and/or made available to target device **104** either directly or at some later time when the target device **104** is coupled to the source device **102**, as shown in FIG. **3**. The transcoded file is typically maintained in a memory on source device **102** in the event that the same format of the source file is suitable for another target device **104** at some later time.

[0039] FIG. **4** shows the block diagram representation and exemplary process of FIG. **3** using several exemplary parameters that better illustrate how the transcode matrix **220** determines target values for the target profile **302** by comparing parameters from the source profile **300** with corresponding parameters in the device profile **301** of the device capabilities **216**(B). In the source profile **300** of FIG. **4**, a bitrate parameter value is 256 kbps (kilobits per second) while the corresponding bitrate parameter in the device profile **301** indicates that the acceptable playback range for the device capabilities **216** (B) is between 0-128 kbps. The resulting target value for the bitrate parameter set by the transcode matrix **220** will be 128 kbps, as shown in the target profile **302** of FIG. **4**. This is the closest value to the source profile value that is within the acceptable range of the device capabilities **216**(B). A sample rate parameter value in the source profile **300** of FIG. **4** is 22 KHz. Because this value already falls within the acceptable range of the corresponding sample rate parameter value in the device capabilities **216**(B) (i.e., 0-48 KHz), the transcode matrix **220** sets the target value for the sample rate parameter at 22 KHz. Likewise, the source profile **300** indicates that the source file **214** has 2 channels, while the device profile **301** of the device capabilities **216**(B) show that acceptable (enumerated) values for the number of channels parameter are 1, 2, and 6. Because 2 channels is an enumerated value in the device profile **301**, the transcode matrix **220** sets the target value for the number of channels parameter to 2.

[0040] Another step the transcode matrix performs following normalization as described above, is a “reduction” step. For example, there can be multiple candidate target profiles contending to be chosen, such as the following:

[0041] Source profile: 128 kbps, 44 kHz

[0042] Device capabilities: Profile 1: (0-160 kbps, 0-48 kHz)

[0043] Profile 2: (96-320 kbps, 0-22 kHz)

[0044] Profile 3: (0-64 kbps, 0-96 kHz)

In this case, the device profiles will be normalized to:

[0045] Profile 1: 128 kbps, 44 kHz

[0046] Profile 2: 128 kbps, 22 kHz

[0047] Profile 3: 64 kbps, 44 kHz

Profile 1 is a better choice because the sample rate in profile 1 is closer to that of the source file.

[0048] The reduction process works by sorting the profiles by a single parameter at a time, and only retaining those profiles that are the best match. In the example above, if bitrate is the first parameter, then the 3rd profile will be eliminated because 128 kbps is a better match to the source bitrate than 64 kbps. If the next parameter is sample rate, then the 2nd profile will be eliminated because profile 1 provides a better match.

[0049] However, in the case where neither profile matches the source exactly (as profile 1 does in the example above), then the lowest closest value takes precedence. That is, if the source parameter is 1000 and the choices on the target are 800, 900, 1050 and 1100, the order of preference would be 900, 800, 1050, 1100.

[0050] As noted briefly above, the transcode matrix **220** may determine that a source file **214** needs to be transcoded for reasons other than finding that one or more parameters from the source profile **300** do not match the corresponding parameters in the device capabilities **216**(B). A user preference is one such reason where transcoding is required even if the target device **104** can support the source file **214** in its original format. If a user specifies a preference (i.e., an override) for a parameter (e.g., audio and/or video bitrate), the transcode matrix **220** will substitute the preferences into the source profile and effectively set the target value for that parameter in the target profile **302** to the preference specified by the user, or at least to a closest match to the user preference. During the determination of transcode need, the source file’s audio and video bitrates, for example, are inspected and compared to the user-preferred bitrates specified for the device. If the source profile **300** shows that the source file **214** has a higher bitrate, then a transcode is needed. During the generation of the target profile **302**, the transcode matrix **220** seeks a closest match to the user preference. This is done by modifying the source profile **300** and setting the audio and/or video bitrate to the user-preferred bitrate(s). If the device profile **301** of the device capabilities **216**(B) indicate that the target device **104** does not support the user preference, the transcode matrix **220** then finds the closest match to the user preference that is within the acceptable range provided by the device profile **301**. For example, if a user prefers that all content be transcoded to an audio bitrate of 192 kbps, but the device only supports up to 160 kbps, then the content will be transcoded to 160 kbps. However, if a user selects a higher bitrate than that of a source file, the source file will not be transcoded if it is supported as is on the target device.

[0051] Another reason the transcode matrix **220** may determine that a source file **214** needs to be transcoded is if the target device places a restriction on the total bitrate. A device may place a restriction on total bitrate (i.e., the sum of audio bitrate and video bitrate) on a per profile basis. Thus, there can exist a device profile **301** that declares support for an audio bitrate of 0-320000 and a video bitrate of 0-700000. However, the total bitrate may be limited to 800000. Thus, a combination of audio bitrate of 320000 and video bitrate of 700000 is not allowable. The transcode matrix **220** therefore checks device profiles to see if the sum of the audio and video bitrates does not exceed the specified total (if a restriction is specified). If the sum of the audio and video bitrates exceeds a specified total, the device profile is skipped, and the transcode matrix **220** continues to the next device profile. If no profiles are found as a result, the profile with the lowest audio bitrate above a certain threshold (32000) is selected, and the video bitrate is adjusted in order to fit within the total restricted bitrate. The lowest audio bitrate is chosen in order to give preference to video bitrate.

Exemplary Methods

[0052] Example methods for determining if a media source file needs to be transcoded for playback on a target playback device and, if so, the proper format needed for transcoding the source file, will now be described with primary reference to the flow diagrams of FIGS. **5-7**. The methods apply to the exemplary embodiments discussed above with respect to FIGS. **1-4**. While one or more methods are disclosed by means of flow diagrams and text associated with the blocks of the flow diagrams, it is to be understood that the elements of the described methods do not necessarily have to be performed in the order in which they are presented, and that alternative orders may result in similar advantages. Furthermore, the methods are not exclusive and can be performed alone or in combination with one another. The elements of the described methods may be performed by any appropriate means including, for example, by hardware logic blocks on an ASIC or by the execution of processor-readable instructions defined on a processor-readable medium.

[0053] A “processor-readable medium,” as used herein, can be any means that can contain, store, communicate, propagate, or transport instructions for use or execution by a processor. A processor-readable medium can be, without limitation, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, device, or propagation medium. More specific examples of a processor-readable medium include, among others, an electrical connection (electronic) having one or more wires, a portable computer diskette (magnetic), a random access memory (RAM) (magnetic), a read-only memory (ROM) (magnetic), an erasable programmable-read-only memory (EPROM or

Flash memory), an optical fiber (optical), a rewritable compact disc (CD-RW) (optical), and a portable compact disc read-only memory (CDROM) (optical).

[0054] At block **502** of method **500**, a transcode matrix **220** receives a file path for a media source file **214**. A transcode manager **218** sends the transcode matrix a file path for a media source file each time a media source file is stored in a media library and is destined to be transferred to a target playback device **104**. The transcode manager generally sends the file path to the transcode matrix and requests that the transcode matrix determine whether the media source file needs to be transcoded for playback on the target playback device, and if so, how the source file should be transcoded.

[0055] At block **504**, the transcode matrix locates the media source file in the media library according to the file path received from the transcode manager. The transcode manager retrieves parameters for the media source file from the media library as shown at block **506**. The transcode manager first tries to access the parameters directly from the media library as shown at block **508**. If this attempt fails, the source file itself is inspected, for example, by opening the source file with a Format SDK to retrieve the source file parameters as shown at block **510**. Then at block **512**, if opening the media source file also fails, the transcode matrix assigns artificial parameters to the media source file.

[0056] In addition, as shown at block **514**, retrieving source file parameters for the media source file can include accessing a bitrate preference or other user preference for the target device that has been expressed by a user. If a bitrate preference (e.g., audio and/or video bitrate) or other user preferences are provided by a user, they are substituted for corresponding parameters of the media source file as shown at block **516**. At block **518**, the transcode matrix generates a source profile based on the parameters retrieved as discussed above regarding block **506**.

[0057] At block **520**, device capabilities **216** are retrieved or accessed from the target playback device. This is generally accomplished by the transcode manager **218** querying the target playback device for the device capabilities. Optionally, as shown at block **522**, after device capabilities **216**(A) are retrieved by transcode manager **218**, they can be serialized into XML format and then saved as device capabilities **216** (B) in the media library **208** so that the transcode matrix and other applications have access to them. In addition, each component of the device capabilities **216** (i.e., including the profile collection, device profiles, and parameter values) can be serialized by itself, resulting in a combined XML. The Appendix section shown below, provides sample device capabilities and sample serialized device capabilities. The samples in the Appendix provide examples of device capabilities for a particular target playback device **104** and examples of what serialized device capabilities may look like.

[0058] In the event the device capabilities do not indicate any restrictions for the target playback device **104**, artificial restrictions will be imposed as shown at block **524**. For example, where no bitrate or sample rate restrictions are indicated in the device capabilities, a 32-160 kbps (kilobits per second) bitrate and 0-44100 KHz sample rate may be imposed on the target device **104**.

[0059] The method **500** continues from FIG. **5** to FIG. **6**, at block **526**. At block **526**, the transcode matrix compares the device capabilities with the source profile. Specifically, the transcode matrix compares parameters in a device profile with like parameters in the source profile. At block **528**, a profile collection from the device capabilities is selected that matches the format code of the media source file. At decision block **530**, the transcode matrix determines if there are any profile collections in the device capabilities that match the format code of the media source file. If not, the transcode matrix determines that no transcode is needed, because the target device supports the media source file, as shown at block **536**. At decision block **530**, if the transcode matrix determines that there is a profile collection that matches the format code of the media source file, then the transcode matrix determines if the matching profile collection contains any device profiles (decision block **532**). If there are no device profiles in the matching profile collection, the transcode matrix again determines that no transcode is needed and that the target device supports the media source file (block **536**). However, if there are one or more device profiles in the matching profile collection, the transcode matrix determines, at decision block **534**, if all the parameters in the source profile match (or fall within range of) corresponding parameters in the device profile. If all the parameters in the source profile match (or fall within range of) corresponding parameters in the device profile, then the transcode matrix again determines that no transcode is needed and that the target device supports the media source file (block **536**). However, if any of the parameters in the source profile do not match (or fall within range of) corresponding parameters in the device profile, then the transcode matrix determines that the media source file must be transcoded, as shown at block **538**.

[0060] The method **500** continues with block **540** of FIG. **7**. At block **540**, the transcode matrix generates a target profile **302** that has target parameter values that match enumerated values of the device profile, or that fall within an acceptable range of the corresponding parameters in the device profile. As shown at block **542**, when setting target parameter values, the transcode matrix selects target values that fall within acceptable parameter ranges indicated in the device profile, but it selects those target values to be as close to the parameter value of the source profile as possible. Thus, where an acceptable range of values in the device profile is 2-10, for example, and the source profile value is 6, then the selected target profile value will be set at 6 also.

[0061] At block **544**, the transcode matrix sends the target profile to the transcode engine. At block **546**, the transcode engine transcodes the media source file according to target parameter values specified in the target profile received from the transcode matrix. As shown at blocks **548** and **550**, respectively, a copy of the transcoded file is then maintained in memory on the source device **102** and transferred to the target playback device at an appropriate time, such as when the target playback device is coupled to the source device for a content synchronization process.

Exemplary Computing Environment

[0062] FIG. **8** illustrates an exemplary computing environment for implementing a source computing device **102** suitable for suitable for determining if a media source file needs to be transcoded for playback on a target playback device and, if so, the proper format needed for transcoding the source file, such as discussed above with reference to FIGS. **1-4**. Although one specific configuration is shown in FIG. **8**, a source computing device **102** may also be implemented in other computing configurations.

[0063] The computing environment **800** includes a general-purpose computing system in the form of a computer **802**.

The components of computer **802** may include, but are not limited to, one or more processors or processing units **804**, a system memory **806**, and a system bus **808** that couples various system components including the processor **804** to the system memory **806**.

[0064] The system bus **808** represents one or more of any of several types of bus structures, including a memory bus or memory controller, a peripheral bus, an accelerated graphics port, and a processor or local bus using any of a variety of bus architectures. An example of a system bus **808** would be a Peripheral Component Interconnects (PCI) bus, also known as a Mezzanine bus.

[0065] Computer **802** includes a variety of computer-readable media. Such media can be any available media that is accessible by computer **802** and includes both volatile and non-volatile media, removable and non-removable media. The system memory **806** includes computer readable media in the form of volatile memory, such as random access memory (RAM) **810**, and/or non-volatile memory, such as read only memory (ROM) **812**. A basic input/output system (BIOS) **814**, containing the basic routines that help to transfer information between elements within computer **802**, such as during start-up, is stored in ROM **812**. RAM **810** contains data and/or program modules that are immediately accessible to and/or presently operated on by the processing unit **804**.

[0066] Computer **802** may also include other removable/non-removable, volatile/non-volatile computer storage media. By way of example, FIG. **8** illustrates a hard disk drive **816** for reading from and writing to a non-removable, non-volatile magnetic media (not shown), a magnetic disk drive **818** for reading from and writing to a removable, non-volatile magnetic disk **820** (e.g., a "floppy disk"), and an optical disk drive **822** for reading from and/or writing to a removable, non-volatile optical disk **824** such as a CD-ROM, DVD-ROM, or other optical media. The hard disk drive **816**, magnetic disk drive **818**, and optical disk drive **822** are each connected to the system bus **808** by one or more data media interfaces **825**. Alternatively, the hard disk drive **816**, magnetic disk drive **818**, and optical disk drive **822** may be connected to the system bus **808** by a SCSI interface (not shown).

[0067] The disk drives and their associated computer-readable media provide non-volatile storage of computer readable instructions, data structures, program modules, and other data for computer **802**. Although the example illustrates a hard disk **816**, a removable magnetic disk **820**, and a removable optical disk **824**, it is to be appreciated that other types of computer readable media which can store data that is accessible by a computer, such as magnetic cassettes or other magnetic storage devices, flash memory cards, CD-ROM, digital versatile disks (DVD) or other optical storage, random access memories (RAM), read only memories (ROM), electrically erasable programmable read-only memory (EEPROM), and the like, can also be utilized to implement the exemplary computing system and environment.

[0068] Any number of program modules can be stored on the hard disk **816**, magnetic disk **820**, optical disk **824**, ROM **812**, and/or RAM **810**, including by way of example, an operating system **826**, one or more application programs **828**, other program modules **830**, and program data **832**. Each of such operating system **826**, one or more application programs **828**, other program modules **830**, and program data **832** (or some combination thereof) may include an embodiment of a caching scheme for user network access information.

[0069] Computer **802** can include a variety of computer/processor readable media identified as communication media. Communication media embodies computer readable instructions, data structures, program modules, or other data in a modulated data signal such as a carrier wave or other transport mechanism and includes any information delivery media. The term "modulated data signal" means a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media includes wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, RF, infrared, and other wireless media. Combinations of any of the above are also included within the scope of computer readable media.

[0070] A user can enter commands and information into computer system **802** via input devices such as a keyboard **834** and a pointing device **836** (e.g., a "mouse"). Other input devices **838** (not shown specifically) may include a microphone, joystick, game pad, satellite dish, serial port, scanner, and/or the like. These and other input devices are connected to the processing unit **804** via input/output interfaces **840** that are coupled to the system bus **808**, but may be connected by other interface and bus structures, such as a parallel port, game port, or a universal serial bus (USB).

[0071] A monitor **842** or other type of display device may also be connected to the system bus **808** via an interface, such as a video adapter **844**. In addition to the monitor **842**, other output peripheral devices may include components such as speakers (not shown) and a printer **846** which can be connected to computer **802** via the input/output interfaces **840**.

[0072] Computer **802** may operate in a networked environment using logical connections to one or more remote computers, such as a remote computing device **848**. By way of example, the remote computing device **848** can be a personal computer, portable computer, a server, a router, a network computer, a peer device or other common network node, and the like. The remote computing device **848** is illustrated as a portable computer that may include many or all of the elements and features described herein relative to computer system **802**.

[0073] Logical connections between computer **802** and the remote computer **848** are depicted as a local area network (LAN) **850** and a general wide area network (WAN) **852**. Such networking environments are commonplace in offices, enterprise-wide computer networks, intranets, and the Internet. When implemented in a LAN networking environment, the computer **802** is connected to a local network **850** via a network interface or adapter **854**. When implemented in a WAN networking environment, the computer **802** includes a modem **856** or other means for establishing communications over the wide network **852**. The modem **856**, which can be internal or external to computer **802**, can be connected to the system bus **808** via the input/output interfaces **840** or other appropriate mechanisms. It is to be appreciated that the illustrated network connections are exemplary and that other means of establishing communication link(s) between the computers **802** and **848** can be employed.

[0074] In a networked environment, such as that illustrated with computing environment **800**, program modules depicted relative to the computer **802**, or portions thereof, may be stored in a remote memory storage device. By way of example, remote application programs **858** reside on a memory device of remote computer **848**. For purposes of illustration, application programs and other executable program components, such as the operating system, are illustrated herein as discrete blocks, although it is recognized that such programs and components reside at various times in different storage components of the computer system **802**, and are executed by the data processor(s) of the computer.

Appendix:

[0075] Sample Device Capabilities

[0076] The following samples represent device capabilities returned to a media player application **204** on source device **102** for an example target playback device **104** that supports audio (including WMA Professional Lossless content with high bitrate), video in WMV format, and still pictures in JPG format. The properties returned by actual target playback devices will differ from these device capabilities according to the actual capabilities of such devices.

```
    FORMAT: 0x00003009 -- 1 configs
    CONFIG: Preference: 1 -- 18 props
    ANY       -- Property: Title
    ANY       -- Property: FileSize
    ANY       -- Property: Duration
    ANY       -- Property: LastModifiedDate
    ANY       -- Property: UserRating
    ENUM      -- Property: NonConsumable -- 2 values
              -- Value:    0 0x00000000
              -- Value:    65535 0x0000FFFF
    ANY       -- Property: FileName
    ANY       -- Property: FormatCode
    ANY       -- Property: Track
    ANY       -- Property: BuyNow
    ANY       -- Property: PersistentUniqueID
    ANY       -- Property: UserEffectiveRating
    ANY       -- Property: PlayCount
    ANY       -- Property: Author
    ANY       -- Property: Genre
    RANGE     -- RangeMin:    8000 -- RangeMax:    48000 -- RangeStep:    50 --
Property: SampleRate
    RANGE     -- RangeMin:    1 -- RangeMax:    1500000 -- RangeStep:    1 --
Property: Bitrate
    RANGE      -- RangeMin:      1 -- RangeMax:      2 -- RangeStep:      1 --
Property: NumChannels
    FORMAT: 0x0000B901 -- 1 configs
    CONFIG: Preference: 1 -- 18 props
    ANY       -- Property: Title
    ANY       -- Property: FileSize
    ANY       -- Property: Duration
    ANY       -- Property: LastModifiedDate
    ANY       -- Property: UserRating
    ENUM      -- Property: NonConsumable -- 2 values
              -- Value:    0 0x00000000
              -- Value:    65535 0x0000FFFF
    ANY       -- Property: FileName
    ANY       -- Property: FormatCode
    ANY       -- Property: Track
    ANY       -- Property: BuyNow
    ANY       -- Property: PersistentUniqueID
    ANY       -- Property: UserEffectiveRating
    ANY       -- Property: PlayCount
    ANY       -- Property: Author
    ANY       -- Property: Genre
    RANGE     -- RangeMin:    8000 -- RangeMax:    48000 -- RangeStep:    50 --
Property: SampleRate
    RANGE     -- RangeMin:    1 -- RangeMax:    1500000 -- RangeStep:    1 --
Property: Bitrate
    RANGE     -- RangeMin:      1 -- RangeMax:      2 -- RangeStep:      1 --
Property: NumChannels
    FORMAT: 0x0000300C -- 1 configs
    CONFIG: Preference: 1 -- 32 props
    ANY       -- Property: Title
    ANY       -- Property: FileSize
    ANY       -- Property: Duration
    ANY       -- Property: LastModifiedDate
    ANY       -- Property: UserRating
    ENUM      -- Property: NonConsumable -- 2 values
              -- Value:    0 0x00000000
              -- Value:    65535 0x0000FFFF
    RANGE     -- RangeMin:    0 -- RangeMax:    320 -- RangeStep:    1 --
Property: width
    ANY       -- Property: FileName
    ANY       -- Property: FormatCode
    ANY       -- Property: ProviderCopyright
    ANY       -- Property: PersistentUniqueID
    ENUM      -- Property: ScanType -- 1 values
              -- Value:    1 0x00000001
```

-continued

```
        ANY       -- Property: UserEffectiveRating
        RANGE     -- RangeMin:    28000 -- RangeMax:    800000 -- RangeStep:    1 --
Property: TotalBitrate
        ANY       -- Property: PlayCount
        RANGE     -- RangeMin:    0 -- RangeMax:    240 -- RangeStep:    1 --
Property: Height
        ANY       -- Property: Description
        ANY       -- Property: FileCreationDate
        ANY       -- Property: Genre
        ENUM      -- Property: KeyFrameDistance -- 1 values
                  -- Value: 3    0x00000003
        ANY       -- Property: SubTitleDescription
        ANY       -- Property: SubTitle
        RANGE     -- RangeMin:    1 -- RangeMax:    2 -- RangeStep:    1 --
Property: NumChannels
        ANY       -- Property: ParentalRating
        RANGE     -- RangeMin:    1 -- RangeMax:    320000 -- RangeStep:    1 --
Property: Bitrate
        ENUM      -- Property: AudioWAVECodec -- 1 values
                  -- Value:    353    0x00000161
        ENUM      -- Property: BufferSize -- 1 values
                  -- Value:    3 0x00000003
        RANGE     -- RangeMin:    15000 -- RangeMax:    30000 -- RangeStep:    1 --
Property: FrameRate
        ENUM      -- Property: QualitySetting -- 1 values
                  -- Value:    50 0x00000032
        RANGE     -- RangeMin:    8000 -- RangeMax:    48000 -- RangeStep:    50 --
Property: SampleRate
        ENUM      -- Property: VideoFourCCCodec -- 4 values
                  -- Value:    827739479 0x31564D57
                  -- Value:    844516695 0x32564D57
                  -- Value:    861293911 0x33564D57
                  -- Value:    1347833175 0x50564D57
        RANGE     -- RangeMin:    28000 -- RangeMax:    736000 -- RangeStep:    1 --
Property: VideoBitrate
        FORMAT: 0x0000B981 -- 1 configs
        CONFIG: Preference: 1 -- 32 props
        ANY       -- Property: Title
        ANY       -- Property: FileSize
        ANY       -- Property: Duration
        ANY       -- Property: LastModifiedDate
        ANY       -- Property: UserRating
        ENUM      -- Property: NonConsumable -- 2 values
                  -- Value:    0 0x00000000
                  -- Value:    65535 0x0000FFFF
        RANGE     -- RangeMin:    0 -- RangeMax:    320 -- RangeStep:    1 --
Property: Width
        ANY       -- Property: FileName
        ANY       -- Property: FormatCode
        ANY       -- Property: ProviderCopyright
        ANY       -- Property: PersistentUniqueID
        ENUM      -- Property: ScanType -- 1 values
                  -- Value:    1 0x00000001
        ANY       -- Property: UserEffectiveRating
        RANGE     -- RangeMin:    28000 -- RangeMax:    800000 -- RangeStep:    1 --
Property: TotalBitrate
        ANY       -- Property: PlayCount
        RANGE     -- RangeMin:    0 -- RangeMax:    240 -- RangeStep:    1 --
Property: Height
        ANY       -- Property: Description
        ANY       -- Property: FileCreationDate
        ANY       -- Property: Genre
        ENUM      -- Property: KeyFrameDistance -- 1 values
                  -- Value:    3 0x00000003
        ANY       -- Property: SubTitleDescription
        ANY       -- Property: SubTitle
        RANGE     -- RangeMin:    1 -- RangeMax:    2 -- RangeStep:    1 --
Property: NumChannels
        ANY       -- Property: ParentalRating
        RANGE     -- RangeMin:    1 -- RangeMax:    320000 -- RangeStep:    1 --
Property: Bitrate
        ENUM      -- Property: AudioWAVECodec -- 1 values
                  -- Value:    353 0x00000161
        ENUM      -- Property: BufferSize -- 1 values
                  -- Value:    3 0x00000003
        RANGE     -- RangeMin:    15000 -- RangeMax:    30000 -- RangeStep:    1 --
```

-continued

```
Property: FrameRate
        ENUM      -- Property: QualitySetting -- 1 values
                  -- Value:    50 0x00000032
        RANGE     -- RangeMin:    8000 -- RangeMax:    48000 -- RangeStep:    50 --
Property: SampleRate
        ENUM      -- Property: VideoFourCCCodec -- 4 values
                  -- Value:    827739479 0x31564D57
                  -- Value:    844516695 0x32564D57
                  -- Value:    861293911 0x33564D57
                  -- Value:    1347833175 0x50564D57
        RANGE     -- RangeMin:    28000 -- RangeMax:    736000 -- RangeStep:    1 --
Property: VideoBitrate
        FORMAT: 0x00003801 -- 1 configs
        CONFIG: Preference: 1 -- 14 props
        ANY       -- Property: Title
        ANY       -- Property: FileSize
        ANY       -- Property: LastModifiedDate
        ANY       -- Property: UserRating
        ENUM      -- Property: NonConsumable -- 2 values
                  -- Value:    0 0x00000000
                  -- Value:    65535 0x0000FFFF
        RANGE     -- RangeMin:    0 -- RangeMax:    320 -- RangeStep:    1 --
Property: Width
        ANY       -- Property: AuthorDate
        ANY       -- Property: FileName
        ANY       -- Property: FormatCode
        ANY       -- Property: PersistentUniqueID
        ANY       -- Property: UserEffectiveRating
        ANY       -- Property: PlayCount
        RANGE     -- RangeMin:    0 -- RangeMax:    240 -- RangeStep:    1 --
Property: Height
        ANY       -- Property: FileCreationDate
        FORMAT: 0x00003001 -- 1 configs
        CONFIG: Preference: 1 -- 7 props
        ANY       -- Property: Title
        ANY       -- Property: FileSize
        ANY       -- Property: LastModifiedDate
        ENUM      -- Property: NonConsumable -- 2 values
                  -- Value:    0 0x00000000
                  -- Value:    65535 0x0000FFFF
        ANY       -- Property: FileName
        ANY       -- Property: FormatCode
        ANY       -- Property: PersistentUniqueID
        FORMAT: 0x0000BA03 -- 1 configs
        CONFIG: Preference: 1 -- 13 props
        RANGE     -- RangeMin:    0 -- RangeMax:    320 -- RangeStep:    1 --
Property: AlbumCoverWidth
        ANY       -- Property: Title
        ANY       -- Property: FileSize
        ANY       -- Property: LastModifiedDate
        ENUM      -- Property: NonConsumable -- 2 values
                  -- Value:    0 0x00000000
                  -- Value:    65535 0x0000FFFF
        ANY       -- Property: FileName
        ANY       -- Property: FormatCode
        ENUM      -- Property: AlbumCoverFormat -- 1 values
                  -- Value: 14337 0x00003801
        ANY       -- Property: PersistentUniqueID
        RANGE     -- RangeMin:    0 -- RangeMax:    240 -- RangeStep:    1 --
Property: AlbumCoverHeight
        ANY       -- Property: AlbumCoverData
        ANY       -- Property: Author
        ANY       -- Property: Genre
        FORMAT: 0x0000BA05 -- 1 configs
        CONFIG: Preference: 1 -- 7 props
        ANY       -- Property: Title
        ANY       -- Property: FileSize
        ANY       -- Property: LastModifiedDate
        ENUM      -- Property: NonConsumable -- 2 values
                  -- Value:    0 0x00000000
                  -- Value:    65535 0x0000FFFF
        ANY       -- Property: FileName
        ANY       -- Property: FormatCode
        ANY       -- Property: PersistentUniqueID
        FORMAT: 0x00003000 -- 1 configs
        CONFIG: Preference: 1 -- 7 props
```

-continued

```
     ANY        -- Property: Title
     ANY        -- Property: FileSize
     ANY        -- Property: LastModifiedDate
     ENUM       -- Property: NonConsumable -- 2 values
                -- Value:     0 0x00000000
                -- Value:     65535 0x0000FFFF
     ANY        -- Property: FileName
     ANY        -- Property: FormatCode
     ANY        -- Property: PersistentUniqueID
     FORMAT: 0x0000B802 -- 1 configs
     CONFIG: Preference: 1 -- 7 props
     ANY        -- Property: Title
     ANY        -- Property: FileSize
     ANY        -- Property: LastModifiedDate
     ENUM       -- Property: NonConsumable -- 2 values
                -- Value:     0 0x00000000
                -- Value:     65535 0x0000FFFF
     ANY        -- Property: FileName
     ANY        -- Property: FormatCode
     ANY        -- Property: PersistentUniqueID
```

[0077] Sample Serialized Device Capabilities

[0078] The following samples are based on the above sample device capabilities, serialized to XML (i.e., what is saved in the media library **208** after stripping off the irrelevant content).

```
<DeviceCaps>
    <ProfileCollection FormatCode=“12297”>
        <Profile>
            <ParameterValue Name=“Bitrate”>
                <Range Minimum=“1” Maximum=“1500000” Step=“1”/>
            </ParameterValue>
            <ParameterValue Name=“NumChannels”>
                <Range Minimum=“1” Maximum=“2” Step=“1”/>
            </ParameterValue>
            <ParameterValue Name=“SampleRate”>
                <Range Minimum=“8000” Maximum=“48000” Step=“50”/>
            </ParameterValue>
        </Profile>
    </ProfileCollection>
    <ProfileCollection FormatCode=“47361”>
        <Profile>
            <ParameterValue Name=“Bitrate”>
                <Range Minimum=“1” Maximum=“1500000” Step=“1”/>
            </ParameterValue>
            <ParameterValue Name=“NumChannels”>
                <Range Minimum=“1” Maximum=“2” Step=“1”/>
            </ParameterValue>
            <ParameterValue Name=“SampleRate”>
                <Range Minimum=“8000” Maximum=“48000” Step=“50”/>
            </ParameterValue>
        </Profile>
    </ProfileCollection>
    <ProfileCollection FormatCode=“12300”>
        <Profile>
            <ParameterValue Name=“AudioWAVECodec”>
                <Enum>
                    <Value>353</Value>
                </Enum>
            </ParameterValue>
            <ParameterValue Name=“Bitrate”>
                <Range Minimum=“1” Maximum=“320000” Step=“1”/>
            </ParameterValue>
            <ParameterValue Name=“BufferSize”>
                <Enum>
                    <Value>3</Value>
                </Enum>
            </ParameterValue>
            <ParameterValue Name=“FrameRate”>
```

-continued

```
                <Range Minimum=“15000” Maximum=“30000” Step=“1”/>
            </ParameterValue>
            <ParameterValue Name=“Height”>
                <Range Minimum=“0” Maximum=“240” Step=“1”/>
            </ParameterValue>
            <ParameterValue Name=“KeyFrameDistance”>
                <Enum>
                    <Value>3</Value>
                </Enum>
            </ParameterValue>
            <ParameterValue Name=“NumChannels”>
                <Range Minimum=“1” Maximum=“2” Step=“1”/>
            </ParameterValue>
            <ParameterValue Name=“QualitySetting”>
                <Enum>
                    <Value>50</Value>
                </Enum>
            </ParameterValue>
            <ParameterValue Name=“SampleRate”>
                <Range Minimum=“8000” Maximum=“48000” Step=“50”/>
            </ParameterValue>
            <ParameterValue Name=“ScanType”>
                <Enum>
                    <Value>1</Value>
                </Enum>
            </ParameterValue>
            <ParameterValue Name=“TotalBitrate”>
                <Range Minimum=“28000” Maximum=“800000” Step=“1”/>
            </ParameterValue>
            <ParameterValue Name=“VideoBitrate”>
                <Range Minimum=“28000” Maximum=“736000” Step=“1”/>
            </ParameterValue>
            <ParameterValue Name=“VideoFourCCCodec”>
                <Enum>
                    <Value>827739479</Value>
                    <Value>844516695</Value>
                    <Value>861293911</Value>
                    <Value>1347833175</Value>
                </Enum>
            </ParameterValue>
            <ParameterValue Name=“Width”>
                <Range Minimum=“0” Maximum=“320” Step=“1”/>
            </ParameterValue>
        </Profile>
    </ProfileCollection>
    <ProfileCollection FormatCode=“47489”>
        <Profile>
            <ParameterValue Name=“DeviceConformanceTemplate”>
                <Enum>
                    <Value>5242963</Value>
                </Enum>
            </ParameterValue>
            <ParameterValue Name=“AudioWAVECodec”>
                <Enum>
                    <Value>353</Value>
                </Enum>
            </ParameterValue>
            <ParameterValue Name=“Bitrate”>
                <Range Minimum=“1” Maximum=“320000” Step=“1”/>
            </ParameterValue>
            <ParameterValue Name=“BufferSize”>
                <Enum>
                    <Value>3</Value>
                </Enum>
            </ParameterValue>
            <ParameterValue Name=“FrameRate”>
                <Range Minimum=“15000” Maximum=“30000” Step=“1”/>
            </ParameterValue>
           <ParameterValue Name=“Height”>
                <Range Minimum=“0” Maximum=“240” Step=“1”/>
            </ParameterValue>
            <ParameterValue Name=“KeyFrameDistance”>
                <Enum>
                    <Value>3</Value>
                </Enum>
            </ParameterValue>
```

-continued

```
            <ParameterValue Name=“NumChannels”>
                <Range Minimum=“1” Maximum=“2” Step=“1”/>
            </ParameterValue>
            <ParameterValue Name=“QualitySetting”>
                <Enum>
                    <Value>50</Value>
                </Enum>
            </ParameterValue>
            <ParameterValue Name=“SampleRate”>
                <Range Minimum=“8000” Maximum=“48000” Step=“50”/>
            </ParameterValue>
            <ParameterValue Name=“ScanType”>
                <Enum>
                    <Value>1</Value>
                </Enum>
            </ParameterValue>
            <ParameterValue Name=“TotalBitrate”>
                <Range Minimum=“28000” Maximum=“800000” Step=“1”/>
            </ParameterValue>
            <ParameterValue Name=“VideoBitrate”>
                <Range Minimum=“28000” Maximum=“736000” Step=“1”/>
            </ParameterValue>
            <ParameterValue Name=“VideoFourCCCodec”>
                <Enum>
                    <Value>827739479</Value>
                    <Value>844516695</Value>
                    <Value>861293911</Value>
                    <Value>1347833175</Value>
                </Enum>
            </ParameterValue>
            <ParameterValue Name=“Width”>
                <Range Minimum=“0” Maximum=“320” Step=“1”/>
            </ParameterValue>
        </Profile>
    </ProfileCollection>
    <ProfileCollection FormatCode=“14337”>
        <Profile>
            <ParameterValue Name=“Height”>
                <Range Minimum=“0” Maximum=“240” Step=“1”/>
            </ParameterValue>
            <ParameterValue Name=“Width”>
                <Range Minimum=“0” Maximum=“320” Step=“1”/>
            </ParameterValue>
        </Profile>
    </ProfileCollection>
    <ProfileCollection FormatCode=“12289”>
        <Profile/>
    </ProfileCollection>
    <ProfileCollection FormatCode=“47619”>
        <Profile>
            <ParameterValue Name=“AlbumCoverFormat”>
                <Enum>
                    <Value>14337</Value>
                </Enum>
            </ParameterValue>
            <ParameterValue Name=“AlbumCoverHeight”>
                <Range Minimum=“0” Maximum=“240” Step=“1”/>
            </ParameterValue>
            <ParameterValue Name=“AlbumCoverWidth”>
                <Range Minimum=“0” Maximum=“320” Step=“1”/>
            </ParameterValue>
        </Profile>
    </ProfileCollection>
    <ProfileCollection FormatCode=“47621”>
        <Profile/>
    </ProfileCollection>
    <ProfileCollection FormatCode=“12288”>
        <Profile/>
    </ProfileCollection>
    <ProfileCollection FormatCode=“47106”>
        <Profile/>
    </ProfileCollection>
</DeviceCaps>
```

CONCLUSION

[0079] Although the invention has been described in language specific to structural features and/or methodological acts, it is to be understood that the invention defined in the appended claims is not necessarily limited to the specific features or acts described. Rather, the specific features and acts are disclosed as exemplary forms of implementing the claimed invention.

1. A transcoding method comprising:

accessing, by a source device, a source file stored at a media library of the source device when the source file is to be transferred to a target device;

generating, by the source device, a source profile for the source file by searching for parameters of the source file in the media library;

generating, by the source device, the source profile for the source file by inspecting the source file to access the parameters of the source file when searching for the parameters in the media library is unsuccessful;

generating, by the source device, the source profile for the source file by assigning an artificial source profile to the source file when obtaining the parameters from inspecting the source file fails; and

determining, by the source device, whether the source file needs to be transcoded by comparing device capabilities of the target device with the source profile.

2. The transcoding method of claim **1**, further comprising transcoding the source file when a user preference for a parameter of the source profile does not match a corresponding parameter of the device capabilities.

3. The transcoding method of claim **1**, further comprising modifying the source profile by substituting a closest match of a user preferred value for a parameter of the source profile when the user preferred value for the parameter of the source profile does not match a current value of the parameter of the source profile.

4. The transcoding method of claim **1**, further comprising identifying a device profile of the target device, the device profile including a total audio bitrate and video bitrate that does not exceed a total bitrate restriction of the target device.

5. The transcoding method of claim **1**, further comprising transcoding the source file when a total bitrate of each of a plurality of device profiles of the target playback device is greater than the total bitrate restriction of the target device.

6. The transcoding method of claim **1**, further comprising imposing an artificial restriction on a parameter of the device capabilities when a restriction for the parameter is not indicated in the device capabilities.

7. The transcoding method of claim **1**, further comprising serializing the device capabilities of the target device into an XML format.

8. A system comprising:

a processor; and

a system memory storing:

a media library including a media source file;

a device profile of a target playback device, the device profile indicating playback parameters of the target playback device; and

a transcode matrix executable by the processor to:

determine whether the media source file is to be transferred to the target playback device;

generate a source profile of the media source file by searching for playback parameters of the source file in the media library;

generate the source profile of the media source file by inspecting the media source file to access the playback parameters of the media source file when searching for the playback parameters in the media library is unsuccessful;

generate the source profile of the media source file by assigning an artificial source profile to the media source file when obtaining the playback parameters of the media source file by inspecting the media source file fails; and

determine whether the media source file needs to be transcoded by comparing the playback parameters of the device profile with the playback parameters of the source profile.

9. The system of claim **8**, wherein the system memory stores a media source application executable by the processor to receive media content from a media content source.

10. The system of claim **8**, wherein the system memory stores a transcode manager executable by the processor to monitor for newly acquired media source files.

11. The system of claim **10**, wherein the transcode manager is executable by the processor to retrieve the device profile from the target playback device.

12. The system of claim **8**, wherein the playback parameters of the source profile and the playback parameters of the device profile include audio codec, audio bitrate, sample rate, number of channels, audio bit depth, or a combination thereof.

13. The system of claim **8**, wherein the playback parameters of the source profile and the playback parameters of the device profile include video codec, video bitrate, a height, a width, a frame rate, or a combination thereof.

14. One or more processor-readable storage media of a source device, the one or more processor-readable storage media comprising processor-executable instructions that when executed by the processor perform acts comprising:

generating a source profile from a media file stored at the source device;

retrieving a device capabilities report from a target playback device, the device capabilities report including a profile collection having a plurality of device profiles specifying capabilities of the target playback device;

identifying a particular device profile of the plurality of device profiles that best matches the source profile;

comparing the source profile with the particular device profile to determine whether the media file needs to be transcoded to enable playback of the media file on the target playback device; and

transcoding the media file to produce a transcoded media file when the media file needs to be transcoded.

15. The one or more processor-readable storage media of claim **14**, further comprising processor-executable instructions that when executed by the processor perform acts comprising:

selecting the profile collection from a plurality of profile collections when a format code of the profile collection matches a format code of the source profile.

16. The one or more processor-readable storage media of claim **14**, wherein the media file is transcoded to produce the transcoded media file before a content synchronization process between the source device and the target playback device.

17. The one or more processor-readable storage media of claim **14**, wherein the media file is transcoded to produce the transcoded media file concurrently with a content synchronization process between the source device and the target playback device.

18. The one or more processor-readable storage media of claim **14**, further comprising processor-executable instructions that when executed by the processor perform acts comprising:

transferring the transcoded media file to the target playback device.

19. The one or more processor-readable storage media of claim **14**, further comprising processor-executable instructions that when executed by the processor perform acts comprising:

storing a copy of the transcoded media file at the source device.

20. The one or more processor-readable storage media of claim **19**, further comprising processor-executable instructions that when executed by the processor perform acts comprising:

transferring the copy of the transcoded media file to an additional target playback device when capabilities of the additional target playback device are suitable with respect to the source profile of the transcoded media file.

* * * * *