US012395695B2

(12) **United States Patent**
Hausmann et al.

(10) **Patent No.: US 12,395,695 B2**
(45) **Date of Patent: *Aug. 19, 2025**

(54) **DYNAMIC INSERTION OF SUPPLEMENTAL AUDIO CONTENT INTO AUDIO RECORDINGS AT REQUEST TIME**

(71) Applicant: **Google LLC**, Mountain View, CA (US)

(72) Inventors: **Rachel Hausmann**, Mountain View, CA (US); **Collin Irwin**, Mountain View, CA (US)

(73) Assignee: **GOOGLE LLC**, Mountain View, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **18/585,962**

(22) Filed: **Feb. 23, 2024**

(65) **Prior Publication Data**

US 2024/0196048 A1 Jun. 13, 2024

Related U.S. Application Data

(63) Continuation of application No. 16/621,334, filed as application No. PCT/US2019/063317 on Nov. 26, 2019, now Pat. No. 11,949,946.

(51) **Int. Cl.**
H04N 21/439 (2011.01)
G06F 16/61 (2019.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04N 21/4394*** (2013.01); ***G10L 15/1822*** (2013.01); ***G11B 27/029*** (2013.01); ***H04N 21/2335*** (2013.01); ***H04N 21/8106*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,625,570 A 4/1997 Vizireanu et al.
6,223,210 B1 4/2001 Hickey
(Continued)

FOREIGN PATENT DOCUMENTS

CN 102945074 2/2013
CN 110192246 8/2019
(Continued)

OTHER PUBLICATIONS

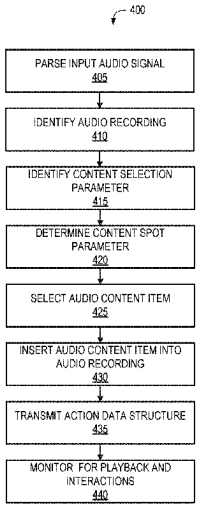
Machine Translated Chinese Search Report Corresponding to Application No. 201980004868X on Dec. 22, 2023.
(Continued)

Primary Examiner — Qin Zhu
(74) *Attorney, Agent, or Firm* — DORITY & MANNING P.A.

(57) **ABSTRACT**

The present disclosure is generally related to inserting supplemental audio content into primary audio content via digital assistant applications. A data processing system can maintain an audio recording of a content publisher and a content spot marker to specify a content spot that defines a time at which to insert supplemental audio content. The data processing system can receive an input audio signal from a client device. The data processing system can parse the input audio signal to determine that the input audio signal corresponds to a request and can identify the audio recording of the content publisher. The data processing system can identify, responsive to the determination, a content selection parameter. The data processing system can select an audio content item using the content selection parameter. The data processing system can generate and transmit an action data structure including the audio recording inserted with audio content item.

20 Claims, 5 Drawing Sheets



(51) **Int. Cl.**

G10L 15/18	(2013.01)
G10L 15/22	(2006.01)
G10L 25/54	(2013.01)
G11B 27/029	(2006.01)
H04L 51/02	(2022.01)
H04L 51/10	(2022.01)
H04L 67/02	(2022.01)
H04L 67/06	(2022.01)
H04N 21/233	(2011.01)
H04N 21/235	(2011.01)
H04N 21/435	(2011.01)
H04N 21/81	(2011.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,684,249	B1	1/2004	Frerichs et al.	
9,348,554	B2	5/2016	Story, Jr. et al.	
9,367,862	B2	6/2016	Yruski et al.	
9,875,751	B2	1/2018	Eggerding et al.	
11,669,296	B2 *	6/2023	Cassidy	G06F 3/16 700/94
2007/0078709	A1	4/2007	Rajaram	
2009/0210946	A1 *	8/2009	Cohen	G06Q 30/0601 705/26.1
2011/0145370	A1 *	6/2011	Nieuwenhuys	H04N 7/17354 709/219
2014/0181243	A1 *	6/2014	Nieuwenhuys	H04N 21/812 709/217
2015/0154632	A1	6/2015	Jindal et al.	
2015/0206168	A1	7/2015	Boggs et al.	
2016/0255377	A1 *	9/2016	Lee	H04N 21/858 725/32
2017/0131967	A1 *	5/2017	Nieuwenhuys	G06F 3/165
2017/0236524	A1	8/2017	Ray et al.	
2018/0157745	A1	6/2018	Williams et al.	
2019/0278555	A1	9/2019	Carvajal et al.	
2019/0279250	A1	9/2019	Gordon et al.	
2020/0090214	A1 *	3/2020	Tushinskiy	G10L 15/22
2020/0168222	A1 *	5/2020	Saito	G06Q 30/0252
2020/0226642	A1 *	7/2020	Turner	G06F 3/165

FOREIGN PATENT DOCUMENTS

JP	2003/244677	8/2003
JP	2007/201742	8/2007
JP	2015/029271	2/2015
KR	10-2008-0065282	7/2008
KR	10-2019-0109499	9/2019
WO	WO 2011/049235	4/2011

OTHER PUBLICATIONS

Office Action for KR Application Serial No. 10-2020-7009966, dated Jan. 25, 2021, 15 pages.

International Search Report and Written Opinion for PCT Application Serial No. PCT/US2019/063317, dated Aug. 20, 2020, 16 pages.

Decision of Rejection for Korean Application Serial No. 10-2020-7009966, dated Jul. 1, 2021, 8 pages.

Anonymous, "CRM ReTargeting", 6 pages.

Anonymous, "Dynamic Ad Insertion for Podcasts: Are They Right for Your Show?", Jul. 18, 2019, https://castos.com/dynamic-ad-insertion-for-podcasts/, retrieved on Sep. 27, 2019, 11 pages.

* cited by examiner

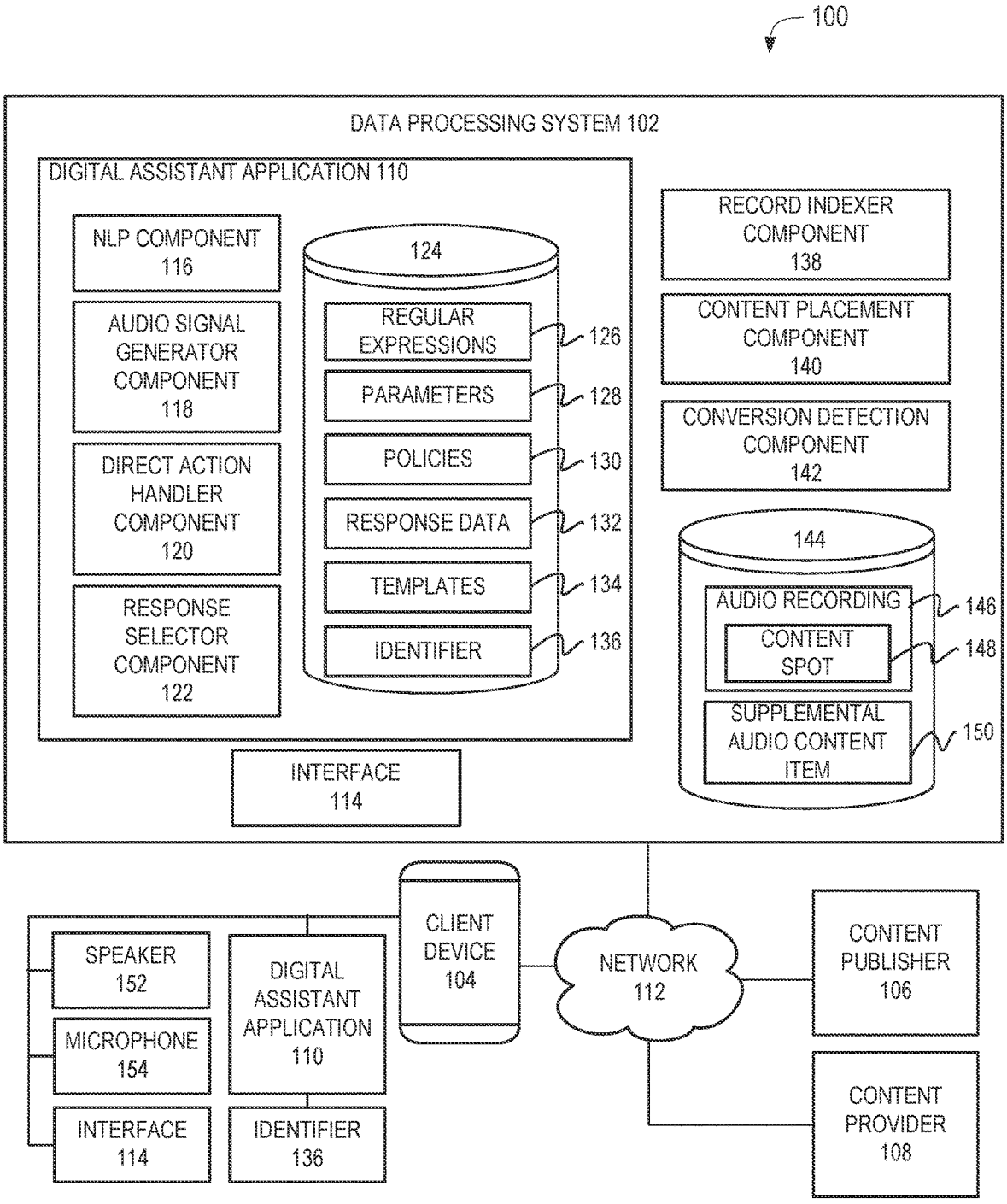

100
DATA PROCESSING SYSTEM 102
DIGITAL ASSISTANT APPLICATION 110
NLP COMPONENT 116
AUDIO SIGNAL GENERATOR COMPONENT 118
DIRECT ACTION HANDLER COMPONENT 120
RESPONSE SELECTOR COMPONENT 122
124
REGULAR EXPRESSIONS
126
PARAMETERS
128
POLICIES
130
RESPONSE DATA
132
TEMPLATES
134
IDENTIFIER
136
INTERFACE 114
RECORD INDEXER COMPONENT 138
CONTENT PLACEMENT COMPONENT 140
CONVERSION DETECTION COMPONENT 142
144
AUDIO RECORDING
146
CONTENT SPOT
148
SUPPLEMENTAL AUDIO CONTENT ITEM
150
CLIENT DEVICE 104
SPEAKER 152
MICROPHONE 154
INTERFACE 114
DIGITAL ASSISTANT APPLICATION 110
IDENTIFIER 136
NETWORK 112
CONTENT PUBLISHER 106
CONTENT PROVIDER 108

FIG. 1

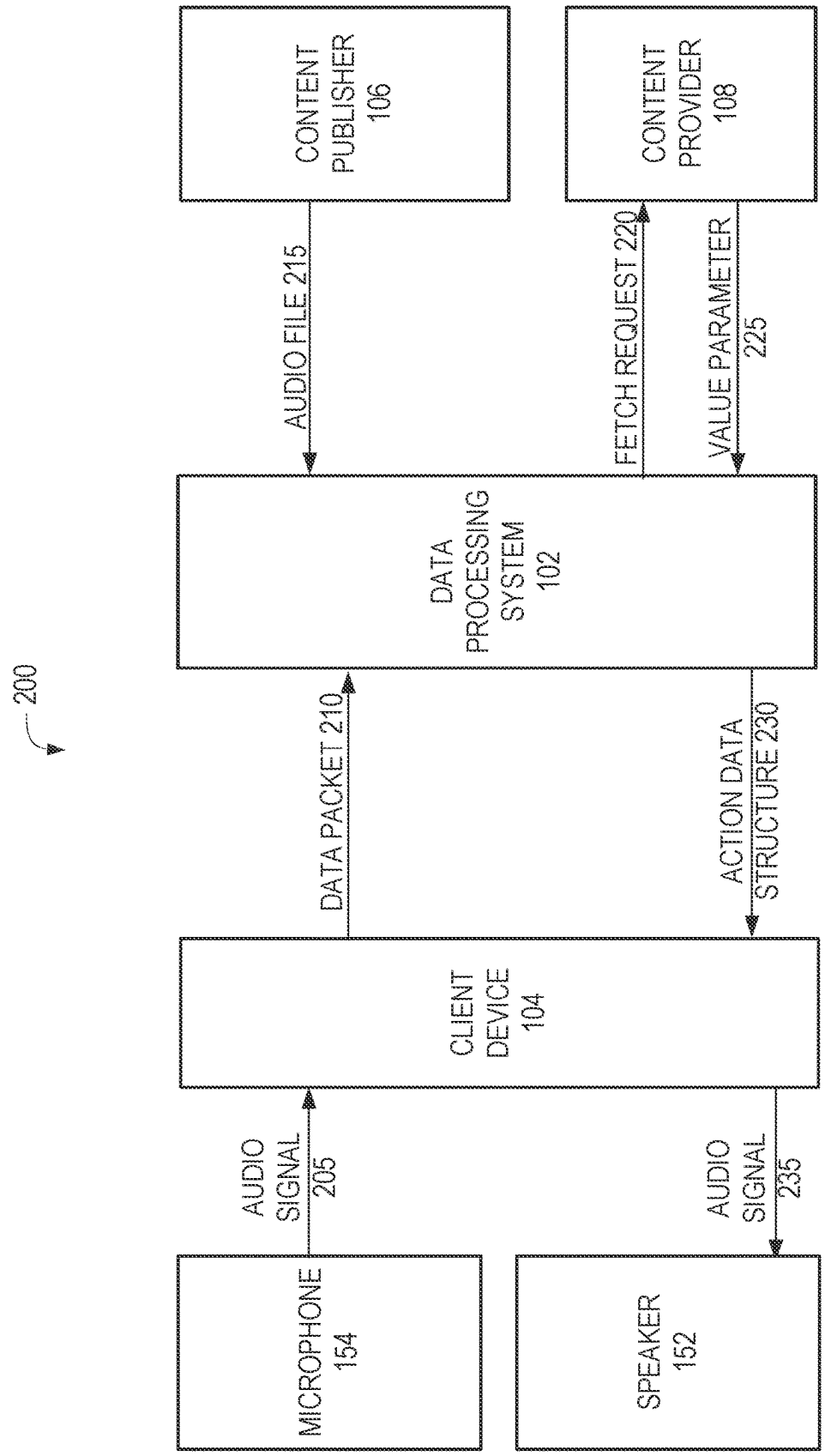

200
CONTENT PUBLISHER 106
CONTENT PROVIDER 108
AUDIO FILE 215
FETCH REQUEST 220
VALUE PARAMETER 225
DATA PROCESSING SYSTEM 102
DATA PACKET 210
ACTION DATA STRUCTURE 230
CLIENT DEVICE 104
AUDIO SIGNAL 205
AUDIO SIGNAL 235
MICROPHONE 154
SPEAKER 152

FIG. 2

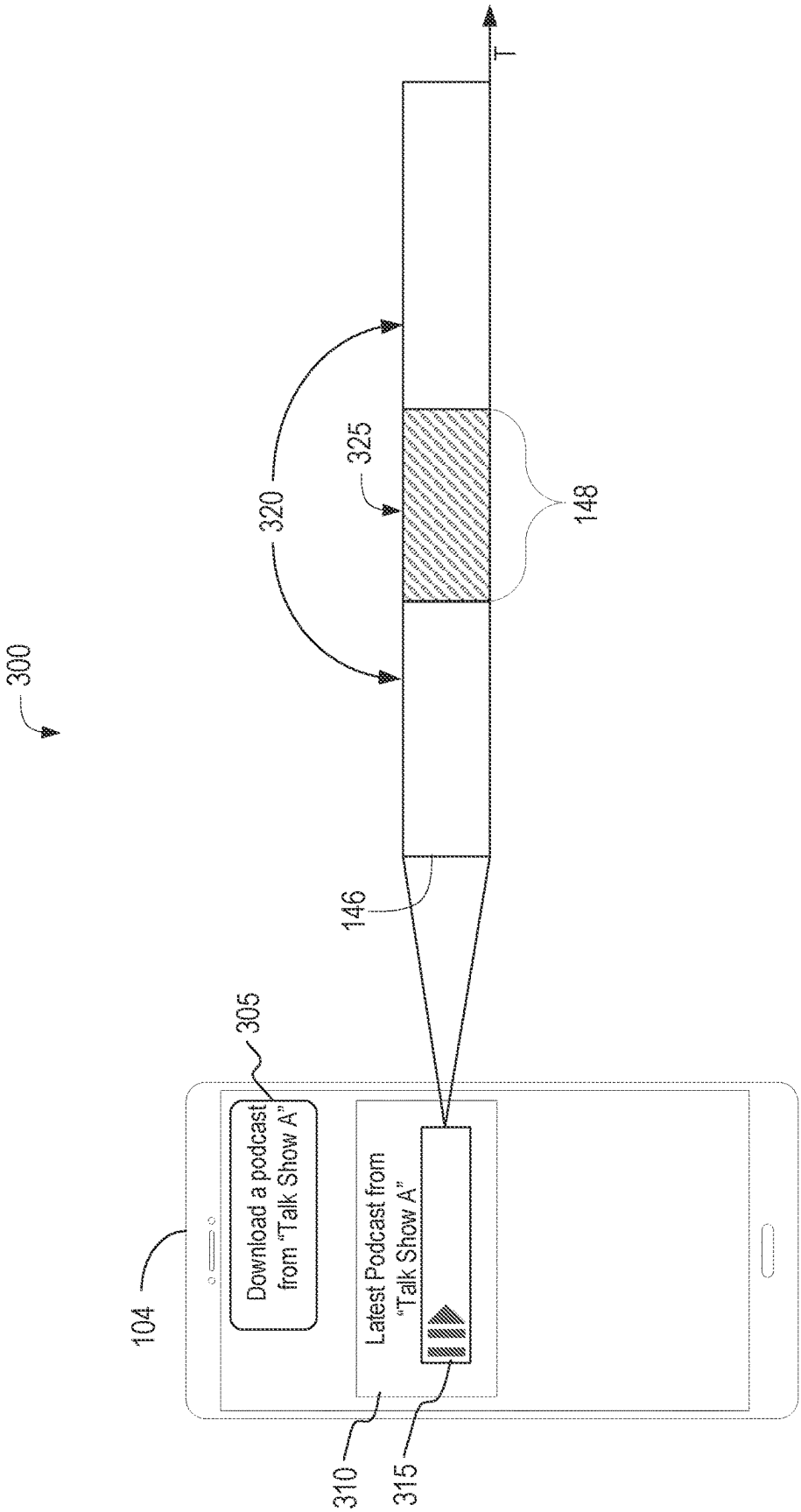

300
T
320
325
148
146
305
Download a podcast from "Talk Show A"
Latest Podcast from "Talk Show A"
104
310
315

FIG. 3

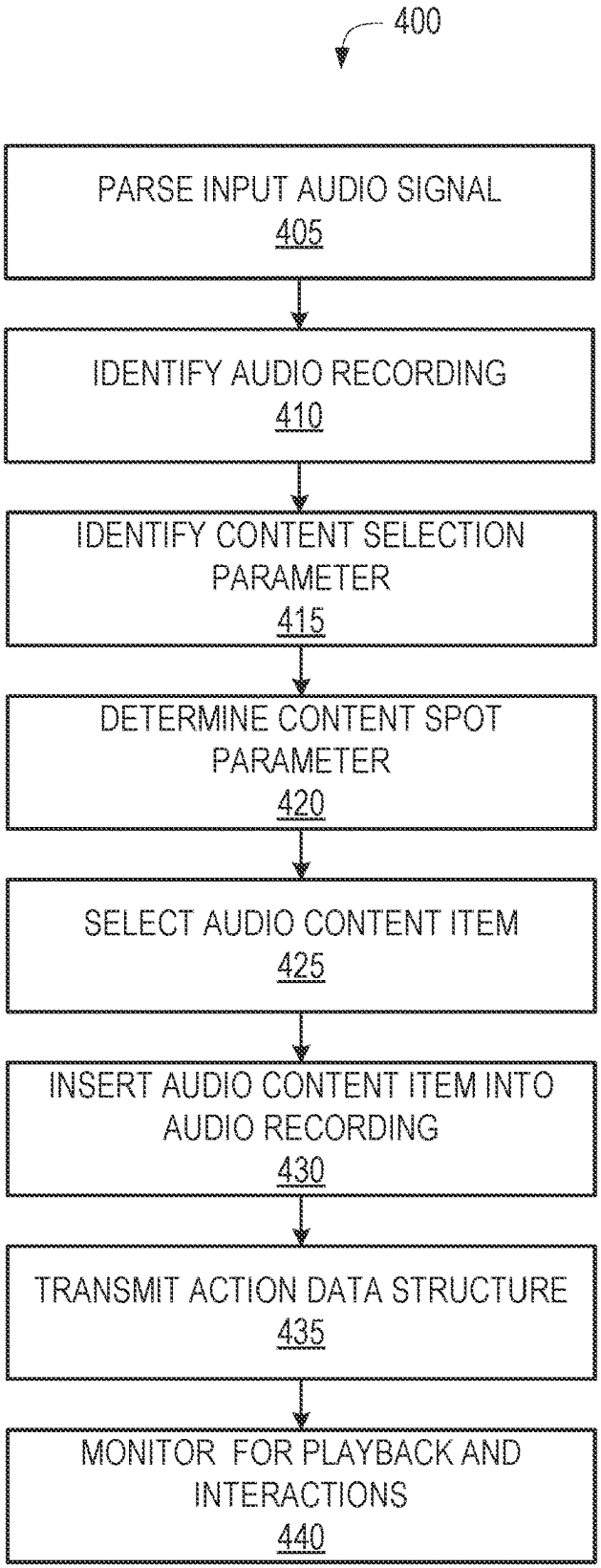

400
PARSE INPUT AUDIO SIGNAL
405
IDENTIFY AUDIO RECORDING
410
IDENTIFY CONTENT SELECTION PARAMETER
415
DETERMINE CONTENT SPOT PARAMETER
420
SELECT AUDIO CONTENT ITEM
425
INSERT AUDIO CONTENT ITEM INTO AUDIO RECORDING
430
TRANSMIT ACTION DATA STRUCTURE
435
MONITOR FOR PLAYBACK AND INTERACTIONS
440

FIG. 4

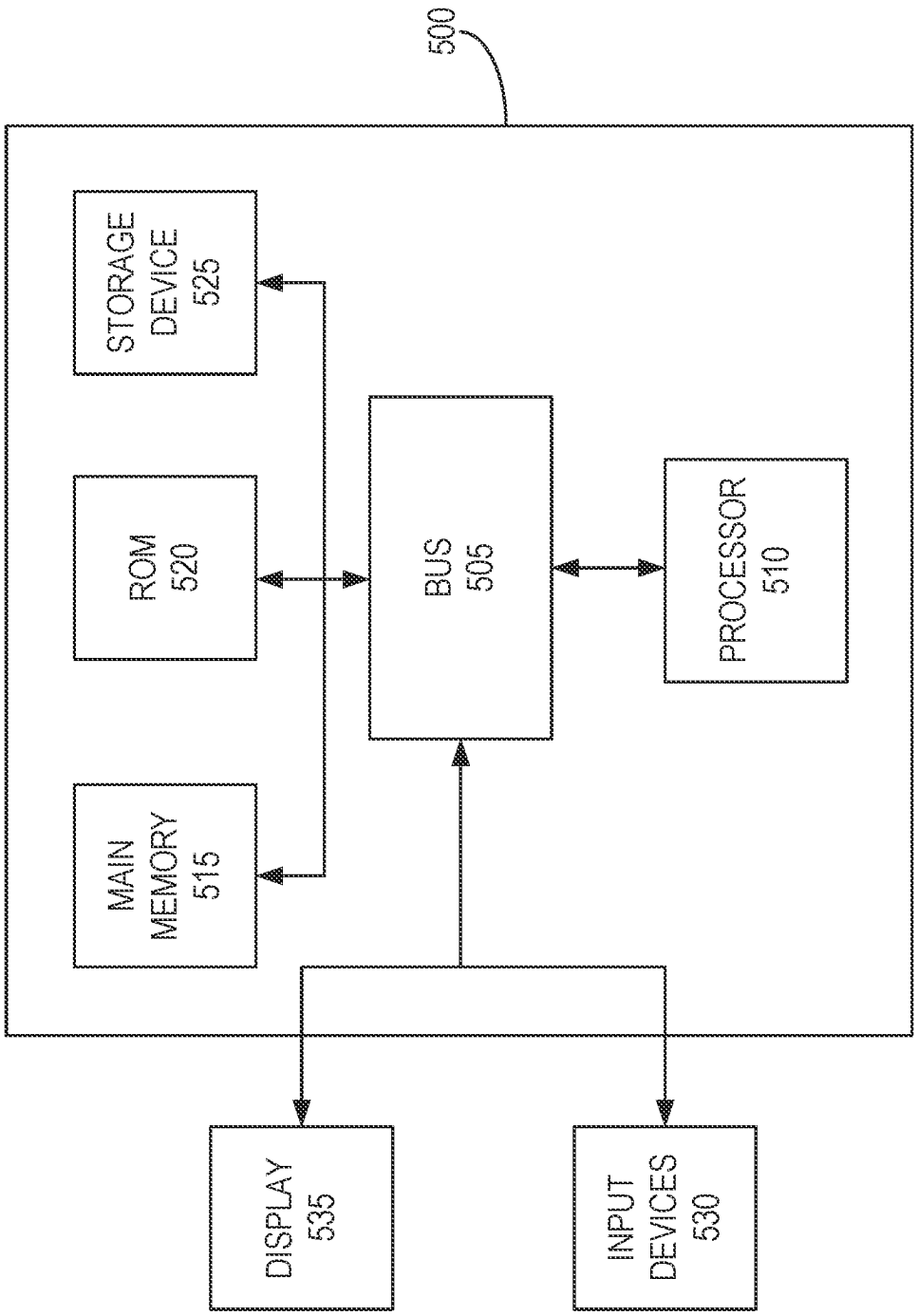

500
STORAGE DEVICE 525
ROM 520
BUS 505
PROCESSOR 510
MAIN MEMORY 515
DISPLAY 535
INPUT DEVICES 530

FIG. 5

DYNAMIC INSERTION OF SUPPLEMENTAL AUDIO CONTENT INTO AUDIO RECORDINGS AT REQUEST TIME

CROSS REFERENCES TO RELATED APPLICATIONS

The present application is a continuation of U.S. application Ser. No. 16/621,334 having a filing date of Dec. 11, 2019, which is a national stage application under 35 U.S.C. § 371 of International Application No. PCT/US2019/063317, titled "DYNAMIC INSERTION OF SUPPLEMENTAL AUDIO CONTENT INTO AUDIO RECORDINGS AT REQUEST TIME," filed Nov. 26, 2019. Applicant claims priority to and the benefit of each of such applications and incorporates all such applications herein by reference in its entirety.

BACKGROUND

Humans may engage in human-to-computer dialogs with interactive software applications referred to herein as "automated assistants" (also referred to as "chatbots," "interactive personal assistants," "intelligent personal assistants," "personal voice assistants," "conversational agents," etc.). For example, users may provide commands, queries, and/or requests (collectively referred to herein as "queries") using free form natural language input which may include vocal utterances converted into text and then processed and/or typed free form natural language input.

SUMMARY

According to an aspect of the disclosure, a system to insert supplemental audio content into primary audio content via digital assistant applications can include a record indexer component executed on a data processing system having one or more processors. The record indexer can maintain, on a database, an audio recording of a content publisher and a content spot marker set by the content publisher to specify a content spot that defines a time at which to insert supplemental audio content during presentation of the audio recording. The system can include a natural language processor component executed on the data processing system. The natural language processor component can receive an audio data packet including an input audio signal that is detected by a sensor of a client device. The natural language processor component can parse the input audio signal from the audio data packet to determine that the input audio signal corresponds to a request for the audio recording from the content publisher. The natural language processor component can identify, based on the request determined from the input audio signal, the audio recording of the content publisher from the database. The system can include a content placement component executed on the data processing system. The content placement component can identify, responsive to the determination that the input audio signal corresponds to the request for the audio recording, an identifier associated with the client device as a content selection parameter. The content placement component can select, for the content spot of the audio recording, an audio content item of a content provider from a plurality of audio content items using the content selection parameter. The system can include an action handler component executed on the data processing system. The action handler component can insert the audio content item into the content spot of the audio recording specified by the content spot marker. The action handler component can generate an action data structure including the audio recording inserted with audio content item at the time defined by the content spot marker. The action handler component can transmit the action data structure to the client device to present the audio recording inserted with the audio content item at the content spot.

According to an aspect of the disclosure, a method of inserting supplemental audio content into primary audio content via digital assistant applications can include maintaining, by a data processing system having one or more processors, on a database, an audio recording of a content publisher and a content spot marker set by the content publisher to specify a content spot that defines a time at which to insert supplemental audio content during presentation of the audio recording. The method can include receiving, by the data processing system, an audio data packet including an input audio signal that is detected by a sensor of a client device. The method can include parsing, by the data processing system, the input audio signal from the audio data packet to determine that the input audio signal corresponds to a request for the audio recording from the content publisher. The method can include identifying, by the data processing system, based on the request determined from the input audio signal, the audio recording of the content publisher from the database. The method can include identifying, by the data processing system, responsive to determining that the input audio signal corresponds to the request for the audio recording, an identifier associated with the client device as a content selection parameter. The method can include selecting, by the data processing system, for the content spot of the audio recording, an audio content item of a content provider from a plurality of audio content items using the content selection parameter. The method can include inserting, by the data processing system, the audio content item into the content spot of the audio recording that defines the time specified by the content spot marker. The method can include generating, by the data processing system, an action data structure including the audio recording inserted with audio content item at the time defined by the content spot marker. The method can include transmitting, by the data processing system, the action data structure to the client device to present the audio recording inserted with the audio content item at the content spot.

These and other aspects and implementations are discussed in detail below. The foregoing information and the following detailed description include illustrative examples of various aspects and implementations and provide an overview or framework for understanding the nature and character of the claimed aspects and implementations. The drawings provide illustration and a further understanding of the various aspects and implementations, and are incorporated in and constitute a part of this specification.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are not intended to be drawn to scale. Like reference numbers and designations in the various drawings indicate like elements. For purposes of clarity, not every component may be labeled in every drawing. In the drawings:

FIG. **1** illustrates a block diagram of an example system to insert supplemental audio content into primary audio content via digital assistant applications, in accordance with an example of the present disclosure.

FIG. **2** illustrates a sequence diagram of an example data flow to insert supplemental audio content into primary audio

content via digital assistant applications in the system illustrated in FIG. **1**, in accordance with an example of the present disclosure.

FIG. **3** illustrates an example client computing device presenting the primary audio content inserted with the supplemental audio content, in accordance with an example of the present disclosure.

FIG. **4** illustrates a flow diagram of a method to insert supplemental audio content into primary audio content via digital assistant applications using the example system illustrated in FIG. **1**, in accordance with an example of the present disclosure.

FIG. **5** is a block diagram of an example computer system.

DETAILED DESCRIPTION

Following below are more detailed descriptions of various concepts related to and implementations of, methods, apparatuses, and systems to insert supplemental audio content into primary audio content via digital assistant applications. The various concepts introduced above and discussed in greater detail below may be implemented in any of numerous ways.

Audio files can include audio content to be presented via loudspeakers on client devices. To generate the audio content for an audio file, a content publisher can record various sources of sources of sound—natural (e.g., a human voice, an animal, or weather) or artificial (e.g., a musical instrument, a synthesizer, or another machine)—using one or more microphones. For example, to create a podcast recording, the speech of a human announcer continuously reading a transcript can be recorded via a microphone. During the recording, the sounds acquired via the microphones can be sampled, quantized, and encoded to form a digital representation (e.g., binary code) of the sound for the audio content of the audio file. Once made available on an information resource (e.g., a webpage), a client device can download the audio file from the information resource and at a later time play the audio file using a media player.

After the audio file is generated, however, it may be difficult to add supplemental audio content supplied by another entity such as a content provider, without interfering or partitioning the audio content already included in the file. This may be especially problematic in that, unlike streaming content provided in near-real time and thus may be readily interrupted for insertion of such content, the audio file can be played offline sometime after the downloading. One approach to insert the supplemental audio content can involve manually recording the supplemental audio content along with the primary audio content of a content publisher. Continuing from the previous podcast example, the transcript itself read aloud by the human announcer to be recorded may include a part for the supplemental audio content between parts for the primary audio content. But this approach can often lead to listeners of the audio file having to hear the same supplemental audio content frequently without any relevance to them. Further, approaches of this type may not be able to adjust content to dynamically changing or contextually driven technical circumstances, such as the fidelity of the audio equipment used to playback the content, the current audio environment of the listener, and prevailing network conditions, among others.

The lack of adaptation of the supplemental audio content to prevailing circumstances can arise from the absence of a content selection process to account for the requesting client device or the primary audio content in identifying the supplemental audio content to insert. From the perspective of the content provider, without such a process, it may be difficult for the content provider to evaluate or identify which audio file or content publisher to provide the supplemental audio content. As a result, without relevant supplemental audio content, the client devices may consume more computing resources and network bandwidth from the generation and transmission of additional requests for potentially relevant content, as well as providing technically sub-optimal output initially. This can also lead to the degradation of the human-computer interaction (HCI) between the user and the client device playing the audio file.

These technical challenges can be exacerbated in the context of digital assistant applications. A digital assistant application can parse an input voice command acquired via a microphone on the client device to identify a request for audio content from a particular content provider. For example, the input voice command parsed by the digital assistant application may be "Download a podcast from 'News Source A.'" The audio file of the content provider that is provided to the digital assistant application can include the supplemental audio content inserted into the audio file and selected without any content selection process. With digital assistant applications, the generation of additional requests for content can consume a substantially greater amount of computing resources and network bandwidth, due to the use of computationally complex natural language processing algorithms.

To address these and other challenges in inserting supplemental audio content into primary audio content in an audio file, the present systems and methods can dynamically select and insert the supplemental audio content at request time. The audio file can have a content spot specified by the content provider that can define a timespan during which to insert and play the supplemental audio content within the primary audio content. Upon identifying that the voice command is a request for an audio file from a particular content provider, the digital assistant application can invoke a content selection service. The content placement service can identify content selection parameters to be used for selecting from supplemental audio content to insert into the content spot. The content selection parameters can include an identifier, such as a device identifier, a cookie identifier, an account identifier, or an account profile, among others. Using the parameters, the content placement service can identify a supplemental audio content from a set of content from various content providers for the content spot of the audio content in the file. Once identified, the digital assistant application can insert the supplemental audio content into the content spot within the audio content. The digital assistant application can provide and return the audio file with the supplemental audio content to the client device for presentation.

With the incorporation of content selection parameters, additional parameters may be used to augment the selection and identification of supplemental audio content to insert into the content spot of the audio content in the audio file. For example, using the identifier, the digital assistant application can monitor whether one of the predefined interactions (e.g., a voice command query for the content provider) occurs at the client device after the provision of the audio file. Based on the number of client devices at which the predefined interactions are detected, the content selection service can determine a content spot parameter for the content spot within the audio content of the audio file. The value for the content spot parameter can be proportional to a likelihood of occurrence of one of the predefined interactions subsequent to presentation of the audio file with the

supplemental audio content. In addition to the content selection parameter, the content selection service can use the content spot parameter to identify the supplemental audio content to insert into the audio content of the file.

Since various parameters are used to select content upon identification of the request, the supplemental audio content inserted into the content spot may be more technically suited to prevailing conditions or may be of more relevance to the user hearing the audio content via the client device. Due to the increase in suitability and/or relevance, a likelihood of a subsequent related interaction via the client device may increase, thereby improving the human-computer interaction (HCI) between the user and the client device. Furthermore, the chances that subsequent voice commands are received by the digital assistant application for additional requests for content can be decreased, thereby reducing the consumption of computing resources and network bandwidth.

FIG. **1**, among others, depicts a block diagram of an example system **100** to insert supplemental audio content into primary audio content via digital assistant applications. The system **100** can include at least one data processing system **102**. The data processing system **102** can include at least one processor and a memory, i.e., a processing circuit. The memory stores processor-executable instructions that, when executed by processor, cause the processor to perform one or more of the operations described herein. The processor may include a microprocessor, an application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA), etc., or combinations thereof. The memory may include, but is not limited to, electronic, optical, magnetic, or any other storage or transmission device capable of providing the processor with program instructions. The memory may further include a floppy disk, CD-ROM, DVD, magnetic disk, memory chip, ASIC, FPGA, read-only memory (ROM), random-access memory (RAM), electrically erasable programmable ROM (EEPROM), erasable programmable ROM (EPROM), flash memory, optical media, or any other suitable memory from which the processor can read instructions. The instructions may include code from any suitable computer programming language. The data processing system **102** can include one or more computing devices or servers that can perform various functions.

The data processing system **102** can include multiple, logically grouped servers and facilitate distributed computing techniques. The logical group of servers may be referred to as a data center, server farm, or a machine farm. The servers can be geographically dispersed. A data center or machine farm may be administered as a single entity, or the machine farm can include a plurality of machine farms. The servers within each machine farm can be heterogeneous-one or more of the servers or machines can operate according to one or more type of operating system platform. The data processing system **102** each can include servers in a data center that are stored in one or more high-density rack systems, along with associated storage systems, located for example in an enterprise data center. In this way, the data processing system **102** with consolidated servers can improve system manageability, data security, the physical security of the system, and system performance by locating servers and high performance storage systems on localized high performance networks. Centralization of all or some of the data processing system **102** components, including servers and storage systems, and coupling them with advanced system management tools allows more efficient use of server resources, which saves power and processing requirements and reduces bandwidth usage. Each of the components of the data processing system **102** can include at least one processing unit, server, virtual server, circuit, engine, agent, appliance, or other logic device such as programmable logic arrays configured to communicate and with other computing devices of the system **100**.

The system **100** can include at least one client device **104**. The client device **104** can include at least one logic device such as a computing device having a processor to communicate with other components of the system **100**. The client devices **104** can include an instance of any of the components described in relation to the data processing system **102**. The client devices **104** can include a desktop computer, laptop, tablet computer, personal digital assistant, smartphone, mobile device, portable computer, thin client computer, virtual server, speaker-based digital assistant, or other computing device.

The system **100** can include at least one content publisher **106**. The content publisher **106** can include servers or other computing devices operated by a content publishing entity to provide primary audio content. For example, the content publisher **106** can be associated with an audio recording entity that records primary audio content. The primary audio content may be a recording of an audio cast (sometimes referred herein as a podcast or an audio podcast). The primary audio content can include one or more breaks defined by the audio recording entity for insertion of other audio content from other entities besides the content publishing entity. The breaks can correspond to a periods (e.g., of silence or other sounds) within the recording in which other content can be inserted. Once recorded, the content publisher **106** can package and generate one or more audio files and make the files available for download via an information resource (e.g., a webpage), a web application, or another program. The audio files can be in any format, such as WAV, MPEG, MP3, RIFF, AAC, OGG, and WMA, among others.

The system **100** can include at least one content provider **108**. The content provider **108** can include servers or other computing devices operated by a content provider entity to provide supplemental audio content. For example, the content provider **108** can be associated with another audio recording entity that records supplemental audio content (sometimes referred herein as third-party audio content). The supplemental audio content can be included or inserted into primary audio content created by the content publisher **106**. For instance, the supplemental audio content recorded by the content provider **108** in the breaks defined by the audio recording entity associated with the content publisher **106**. Once recorded, the content provider **108** can package and generate one or more audio files and make the files available for presentation, in conjunction with the primary audio content, via an information resource (e.g., a webpage), a web application, or another program. The audio files can be in any format, such as WAV, MPEG, MP3, RIFF, AAC, OGG, and WMA, among others.

The system **100** can include at least one network **112**. The components of the system **100**, such as the data processing system **102**, the client device **104**, the content publisher **106**, and the content provider **108**, can communicate over a network **112**. The network **112** can include, for example, a point-to-point network, a broadcast network, a wide area network, a local area network, a telecommunications network, a data communication network, a computer network, an ATM (Asynchronous Transfer Mode) network, a SONET (Synchronous Optical Network) network, a SDH (Synchronous Digital Hierarchy) network, an NFC (Near-Field Com-

munication) network, a local area network (LAN), a wireless network or a wireline network, and combinations thereof. The network **112** can include a wireless link, such as an infrared channel or satellite band. The topology of the network **112** may include a bus, star, or ring network topology. The network **112** can include mobile telephone networks using any protocol or protocols used to communicate among mobile devices, including advanced mobile phone protocol (AMPS), time division multiple access (TDMA), code-division multiple access (CDMA), global system for mobile communication (GSM), general packet radio services (GPRS), or universal mobile telecommunications system (UMTS). Different types of data may be transmitted via different protocols, or the same types of data may be transmitted via different protocols.

The data processing system **102** can include at least one instance of a digital assistant application **110**. The digital assistant application **110** can include at least one natural language processor (NLP) component **116** to parse audio-based inputs. The digital assistant application **110** can include at least one audio signal generator component **118** to generate audio-based signals. The digital assistant application **110** can include at least one direct action handler component **120** to generate action data structures. The digital assistant application **110** can include at least one response selector component **122** to select responses to audio-based input signals. The digital assistant application can include at least one data repository **124** to maintain data for the digital assistant application **110**. One or more of the NLP component **116**, the audio signal generator component **118**, the direct action handler component **120**, the response selector component **122**, and the data repository **124** can be separate from the instance of the digital assistant application **110** on the data processing system **102** or from one another.

The data repository **124** can include one or more local or distributed databases and can include a database management system. The data repository **124** can include computer data storage or memory and can store one or more regular expressions **126**, one or more parameters **128**, one or more policies **130**, response data **132**, templates **134**, and at least one identifier **136**, among other data. The parameters **128**, policies **130**, and templates **134** can include information such as rules about a voice based session between the client devices **104** and the data processing system **102**. The regular expressions **126** can include rules about conducting the voice-based session between the client devices **104** and the data processing system **102** via the digital assistant application **110**. The regular expressions **126**, parameters **128**, policies **130**, and templates **134** can also include information for another digital assistant application **110** received from another source (e.g., the data processing system **102** and the client device **104**). The response data **132** can include content items for audio output or associated metadata, as well as input audio messages that can be part of one or more communication sessions with the client device **104**. The identifier **138** can include information regarding the client device **104** (e.g., authentication credentials to access and execute the digital assistant application **110**).

The data processing system **102** can include at least one record indexer component **138** to receive and maintain audio content from the content publisher **106** and the content provider **108**. The data processing system **102** can include at least one content placement component **140** to select supplemental audio content from the content provider **108** for insertion into the primary audio content of the content publisher **106**. The data processing system **102** can include at least one conversion detection component **142** to monitor interactions in connection with provision of the audio content. The data processing system **102** can also include at least one data repository **144** to maintain data for the record indexer component **138**, the content placement component **140**, or the conversion detection component **142**, among others. One or more of the record indexer component **138**, the content placement component **140**, the conversion detection component **142**, and the data repository **144** can be separate from the instance of the digital assistant application **110** on the data processing system **102** (e.g., as depicted). One or more of the record indexer component **138**, the content placement component **140**, the conversion detection component **142**, and the data repository **144** can be a part of the instance of the digital assistant application **110** on the data processing system **102**.

The data processing system **102** can include at least one interface **114**. The interface **114** can be configured, constructed, or operational to receive and transmit information using, for example, data packets. The interface **114** can receive and transmit information using one or more protocols, such as a network protocol. The interface **114** can include a hardware interface, software interface, wired interface, or wireless interface. The interface **114** can be a data interface or a network interface that enables the components of the system **100** to communicate with one another. The interface **114** of the data processing system **102** can provide or transmit one or more data packets that include the action data structure, audio signals, or other data via the network **112**. For example, the data processing system **102** can provide the output signal from the data repository **124** or from the audio signal generator component **118** to the client devices **104**.

The data processing system **102** can also instruct, via data packet transmissions, the client devices **104** to perform the functions indicated in the action data structure. The output signal can be obtained, generated, transformed to, or transmitted as one or more data packets (or other communications protocol) from the data processing system **102** (or other computing device) to the client devices **104**. The interface **114** can facilitate translating or formatting data from one format to another format. For example, the interface **114** can include an application programming interface ("API") that includes definitions for communicating between various components, such as software components. An application, script, program, or other components that are associated with the data processing system **102** can be installed at the client devices **104**. The application can enable the client devices **104** to communicate input audio signals (and other data) to the interface **114** of the data processing system **102**.

The data processing system **102** can include an application, script, or program installed at the client device **104**, such as the instance of the digital assistant application **110** on the client device **104** to communicate input audio signals to the interface **114** of the data processing system **102** and to drive components of the client computing device to render output audio signals or visual output. The data processing system **102** can receive data packets, a digital file, or other signals that include or identify an input audio signal (or input audio signals). The client device **104** can detect the audio signal via the speaker **152** and convert the analog audio signal to a digital file via an analog-to-digital converter. For example, the audio driver can include an analog-to-digital converter component. The pre-processor component can convert the audio signals to a digital file that can be transmitted via data packets over network **112**.

The client device **104** can include at least instance of the digital assistant application **110**. The functionalities of the data processing system **102**, such as the digital assistant application **110**, can be included or otherwise be accessible from the client device **104** (e.g., via the interface **114**). The functionalities of the data processing system **102** may correspond to the functionalities or interface with the digital assistant application **110** executing on the client devices **104**. The client devices **104** can each include and execute a separate instance of the one or more components of the digital assistant application **110**. The client devices **104** can otherwise have access to the functionalities of the components of the digital assistant application **110** on the data processing system **102** via the network **112**. For example, the client device **104** can include the functionalities of the NLP component **116** and access the remainder of the components of the digital assistant application **110** via the network **112** to the data processing system **102**.

The client device **104** can be associated with an end user that enters voice queries as audio input into the client device **104** (via the microphone **154** or speaker **152**) and receives audio (or other) output from the data processing system **102** to present, display, or render to the end user of the client device **104**. The digital component can include a computer-generated voice that can be provided from the data processing system **102** to the client device **104**. The client device **104** can render the computer-generated voice to the end user via the speaker **152**. The computer-generated voice can include recordings from a real person or computer-generated language. The client device **104** can provide visual output via a display device communicatively coupled to the client device **104**.

The client device **104** can include, interface, or otherwise communicate with at least one speaker **152** and at least one microphone **154**. The client device **104** can include an audio driver to provide a software interface with the speaker **152** and the microphone **154**. The audio driver can execute instructions provided by the data processing system **102** to control the speaker **152** to generate a corresponding acoustic wave or sound wave. The audio driver can execute an audio file or other instructions to convert an acoustic wave or sound wave acquired from the microphone **154** to generate audio data. For example, the audio driver can execute an analog-to-driver converter (ADC) to transform the acoustic wave or sound wave to the audio data.

The functionalities of the digital assistant application **110** can be allocated or performed by the instance on the data processing system **102** and the client device **104**. For example, the instance of the digital assistant application **110** on the client device **104** can detect a keyword and perform an action based on the keyword. The digital assistant application **110** on the client device **104** can be an instance of the digital assistant application **110** executed at the data processing system **102** or can perform any of the functions of the digital assistant application **110**. The instance of the digital assistant application **110** on the client device **104** can filter out one or more terms or modify the terms prior to transmitting the terms as data to the data processing system **102** (e.g., the instance of the digital assistant application **110** on the data processing system **102**) for further processing. The instance of the digital assistant application **110** on the client device **104** can convert the analog audio signals detected by the speaker **152** into a digital audio signal and transmit one or more data packets carrying the digital audio signal to the data processing system **102** via the network **112**. The instance of the digital assistant application **110** on the client device **104** can transmit data packets carrying some or the entire input audio signal responsive to detecting an instruction to perform such transmission. The instruction can include, for example, a trigger keyword or other keyword or approval to transmit data packets comprising the input audio signal to the data processing system **102**.

The instance of the digital assistant application **110** on the client device **104** can perform pre-filtering or pre-processing on the input audio signal to remove certain frequencies of audio. The pre-filtering can include filters such as a low-pass filter, high-pass filter, or a bandpass filter. The filters can be applied in the frequency domain. The filters can be applied using digital signal processing techniques. The filter can be configured to keep frequencies that correspond to a human voice or human speech, while eliminating frequencies that fall outside the typical frequencies of human speech. For example, a bandpass filter can be configured to remove frequencies below a first threshold (e.g., 70 Hz, 75 Hz, 80 Hz, 85 Hz, 90 Hz, 95 Hz, 100 Hz, or 105 Hz) and above a second threshold (e.g., 200 Hz, 205 Hz, 210 Hz, 225 Hz, 235 Hz, 245 Hz, 255 Hz, or 3 kHz). Applying a bandpass filter can reduce computing resource utilization in downstream processing. The instance of the digital assistant application **110** on the client device **104** can apply the bandpass filter prior to transmitting the input audio signal to the data processing system **102**, thereby reducing network bandwidth utilization. Based on the computing resources available to the client device **104** and the available network bandwidth, it may be more efficient in some instances to provide the input audio signal to the data processing system **102** to allow the data processing system **102** to perform the filtering. The instance of the digital assistant application **110** on the client device **104** can apply additional pre-processing or pre-filtering techniques such as noise reduction techniques to reduce ambient noise levels that can interfere with the natural language processor. Noise reduction techniques can improve accuracy and speed of the natural language processor, thereby improving the performance of the data processing system **102** and manage rendering of a graphical user interface provided via the display.

The NLP component **116** of the instance of the digital assistant application **110** running on the data processing system **102** can receive the audio data packet including the input audio signal detected by the microphone **154** of the client device **104**. The data packets can provide a digital file. The NLP component **116** can receive or obtain the digital file or data packets comprising the audio signal and parse the audio signal. In providing the input audio signal to the data processing system **102**, the NLP component **116** on the client device **104** can generate at least one audio data packet (sometimes referred herein in general as data packet). The audio data packet can include the input audio signal acquired by the microphone **154** of the client device **104**. The audio data packet can include data related to the client device **104**, the digital assistant application **110** running on the client device, or the transmission of the input audio signal, such as one or more identifiers **136**. The identifier **136** can include, for example: a device identifier referencing the client device **104**, an account identifier associated with a user of digital assistant application **110** (e.g., as part of authentication credentials), or a session or cookie identifier assigned to current use of the digital assistant application **110**, among others. The data in the audio data packet can also include metadata, such as a device attribute associated with the client device **104**, an application attribute associated with the digital assistant application **110**, and a trait characteristic associated with an account used to log into the digital assistant application **110**, among others. Upon generation,

the NLP component **116** on the client device **104** can transmit the audio data packet to the data processing system **102**. Subsequently, the instance of the digital assistant application **110** running on the data processing system **102** can receive the audio data packet and can process the audio data packet including the input audio signal and any additional data.

To parse the input audio signal, the NLP component **116** can be configured with techniques for understanding natural language and enabling the data processing system **102** to derive meaning from human or natural language input. Using various natural language processing techniques, the NLP component **116** can provide for interactions between a human (e.g., the user of the client device **104**) and a computer (e.g., the client device **104** running on the digital assistant application **110**). The NLP component **116** can include or be configured with techniques based on machine learning, such as statistical machine learning. The NLP component **116** can utilize decision trees, statistical models, or probabilistic models to parse the input audio signal. The NLP component **116** can perform, for example, functions such as named entity recognition (e.g., given a stream of text, determine which items in the text map to names, such as people or places, and what the type of each such name is, such as person, location (e.g., "home"), or organization), natural language generation (e.g., convert information from computer databases or semantic intents into understandable human language), natural language understanding (e.g., convert text into more formal representations such as first-order logic structures that a computer module can manipulate), machine translation (e.g., automatically translate text from one human language to another), morphological segmentation (e.g., separating words into individual morphemes and identify the class of the morphemes, which can be challenging based on the complexity of the morphology or structure of the words of the language being considered), question answering (e.g., determining an answer to a human-language question, which can be specific or open-ended), or semantic processing (e.g., processing that can occur after identifying a word and encoding its meaning in order to relate the identified word to other words with similar meanings).

The NLP component **116** can convert the input audio signal into recognized string by comparing the input signal against a stored, representative set of audio waveforms (e.g., in the data repository **124**) and choosing the closest matches. The set of audio waveforms can be stored in data repository **124** or other database accessible to the data processing system **102**. The representative waveforms are generated across a large set of users, and then may be augmented with speech samples from the user. After the audio signal is converted into recognized text, the NLP component **116** matches the text to words that are associated, for example via training across users or through manual specification, with actions that the data processing system **102** can serve. The NLP component **116** can determine that the input audio signal acquired from the microphone **154** does not contain any recognizable strings. The NLP component **116** can determine that the input audio signal contains silence (e.g., with a maximum amplitude of less than 0 dB) in determining that the input audio signal does not contain any recognizable strings. Additionally, the NLP component **116** can determine a signal-to-noise (SNR) of the input audio signal. The NLP component **116** can compare the SNR of the input audio signal to a threshold SNR (e.g., −20 dB). Responsive to the determination the SNR of the input audio signal is greater than the threshold SNR, the NLP component **116** can determine that the input audio signal does not contain any recognizable strings.

The NLP component **116** can receive and process image or video input signals, in addition to, or instead of, input audio signals. The NLP component **116** can convert image or video input to text or digital files. The NLP component **116** can process, analyze, or interpret image or video input to perform actions, generate requests, or select or identify data structures. The data processing system **102** can process the image or video input signals using, for example, image interpretation techniques, computer vision, a machine learning engine, or other techniques to recognize or interpret the image or video to convert the image or video to a digital file. The one or more image interpretation techniques, computer vision techniques, or machine learning techniques can be collectively referred to as imaging techniques. The data processing system **102** (e.g., the NLP component **116**) can be configured with the imaging techniques, in addition to, or instead of, audio processing techniques.

From the input audio packet, the NLP component **116** can obtain or identify the input audio signal acquired by the microphone **154** of the client device **104**. Upon obtaining, the NLP component **116** partition or divide the input audio signal into one or more audio segments of a time duration (e.g., 15 seconds to 2 minutes) to process or parse each segment. By parsing, the NLP component **116** can identify one or more words from the input audio signal. Based on the identified words, the NLP component **116** can determine whether the input audio signal corresponds to a request for audio content from a particular content publisher **106**. The determination can be based on whether the identified match a formatting for the request for audio content. The formatting can be indicated or specified by the regular expressions **126**, the parameters **128**, the policies **130**, and the templates **134** maintained on the data repository **124**. The formatting for the request for audio content can be comprised of: a trigger word indicating an intent to retrieve, a type of audio content to be retrieved, and an entity from which the audio content is to be retrieved. For example, the words recognized by the NLP component **116** from the input audio signal can include "Download a podcast from the News Channel XYZ." In this example, the trigger keyword can be "Download," the object can be "a podcast," and the originating entity can be "News Channel XYZ."

With the identification of the words from the input audio signal, the NLP component **116** can determine whether the words correspond or match the formatting for the request for audio content. The determination can be performed using one or more natural language processing techniques. For example, question-answering can be employed to determine the trigger keyword and entity recognition can be used to identify the type of audio content and the originating entity. In response to determining that the words from the input audio request does not match the formatting, the NLP component **116** can determine that the input audio signal does not correspond to the request for audio content. Furthermore, the NLP component **116** can perform additional actions to carry out the other type of request indicated in the words of the input audio signal. Conversely, in response to determining that words match the formatting, the NLP component **116** can determine that the input audio corresponds to the request for audio content. Furthermore, the digital assistant application **110** and the data processing system **102** can perform additional actions to fufill the request in retrieving the audio content from the content publisher **106**.

The record indexer component **138** executing on the data processing system **102** can maintain a set of audio recordings **146** on the data repository **144**. In maintaining the data repository **144**, the record indexer component **138** can receive the audio recording **146** from one of the content publishers **106**. Upon receipt, the record indexer component **138** can store the audio recording **146** onto the data repository **144**. The record indexer component **138** can also identify the content publisher **106** from which the audio recording **146** is received, associate the audio recording **146** with the content publisher **106**, and store the association between the audio recording **146** and the content publisher **106**. Each audio recording **146** can be provided or received from one of the content publishers **106** and can be provided via downloading to the digital assistant application **110** on the client device **104**. The audio recording **146** can include one or more audio files in any type of format, such as WAV, MPEG, MP3, RIFF, AAC, OGG, and WMA, among others. The audio recording **146** can include the primary audio content created by the associated content publisher **106**. In addition to the primary audio content, the audio recording **146** can include at least one content spot **148**. The content spot **148** can define a portion of the primary audio content during which supplemental audio content is to be presented. The content spot **148** can be specified or provided by the content publisher **106** using a corresponding content spot marker. The content spot marker can define a time or a time window during which the supplemental content is to be played during the presentation of the primary audio content in the audio recording **146**.

In addition, the record indexer component **138** maintain supplemental audio content items **150** (referred hereinafter generally as audio content item **150**) on the data repository **144**. In maintaining the data repository **144**, the record indexer component **138** can receive the audio content item **150** from the content provider **108**. Upon receipt, the record indexer component **138** can store the audio recording **146** onto the data repository **144**. The record indexer component **138** can also identify the content provider **108** from which the audio content item **150** is received, associate the audio content item **150** with the content provider **108**, and store the association between the audio content item **150** and the content provider **108**. Each audio content item **150** can be provided or received from one of the content provider **108** and can be provided as part of the audio recording **146** via downloading onto the digital assistant application **110** on the client device **104**. Each audio content item **150** can include one or more audio files in any type of format, such as WAV, MPEG, MP3, RIFF, AAC, OGG, and WMA, among others. The audio content item **150** can include the supplemental audio content created by the associated content provider **108**. The supplemental audio content of the audio content item **150** can be inserted into the content spot **148** of one of the audio recordings **146**. Once inserted, the supplemental audio content of the audio content item **150** presented before, during, or after the primary audio content as specified by the content spot marker for the content spot **148**.

In response to determining that the input audio signal corresponds to the request for audio content, the NLP component **116** can identify the audio recording **146** from the data repository **144** to provide to the digital assistant application **110** on the client device **104**. Based on the words parsed from the input audio signal, the NLP component **116** can identify the content publisher **106** whose audio content is associated with the request. For example, the NLP component **116** can use entity recognition to identify the content publisher entity associated with the content publisher **106**. With the identification of the content publisher **106** associated with the request, the NLP component **116** can access the data repository **144** to identify a subset of audio recordings **146** belonging to the content publisher **106**. The NLP component **116** can invoke the record indexer component **138** to search for and retrieve at least one of the audio recordings **146** from the data repository **144** using the identified content publisher **106**. For example, the record indexer component **138** can search for the most recent audio recording **146** from the content publisher **106** that is stored and maintained on the data repository **144**. From the subset, the NLP component **116** can identify one audio recording **146** to provide based on the words parsed from the input audio signal.

The content placement component **140** executing on the data processing system **102** can select or identify at least one of the audio content items **150** to insert into each content spot **148** of the audio recording **146** associated with the request. With the determination that the input audio signal corresponds to the request for content, the content placement component **140** can identify at least one content selection parameter. The content selection parameter can be used to select one of the audio content items **150** to include into the content spot **148** of the audio recording **146**. The content selection parameter can include, for example: the identifier **136** (e.g., the device identifier, the account identifier, or the session or cookie identifier); at least one device attribute associated with the client device **104** (e.g., a device type, a device capability, a network address, and a geographic location); at least one application attribute associated with the digital assistant application **110** on the client device **104** (e.g., an application name, a version, or presentation capabilities); and at least one trait characteristic associated with the account identifier used to log into the digital assistant application **110** (e.g., account profile, interest identifiers, or a user segment), among others.

To identify the content selection parameter, the content placement component **140** can parse the audio data packet provided by the digital assistant application **110** on the client device **104** to identify the data included therein. By parsing, the content placement component **140** can extract or identify the identifier **136** included in the audio data packet. Once identified, the content placement component **140** can use the identifier **136** from the audio data packet as one of the content selection parameters. In lieu of or in addition to parsing, the content placement component **140** can retrieve the identifier **136** from the digital assistant application **110** on the client device **104** via an application programming interface (API). For example; the audio data packet can lack the identifier **136**, and the digital assistant application **110** may have been authenticated for operations using the identifier **136**. In this example, the content placement component **140** can invoke a function call in accordance with the specifications of the API used by the digital assistant application **110** to fetch the identifier **136**. Furthermore, the content placement component **140** can parse the audio data packet to identify the metadata included therein, such as the device attribute, the application attribute, and the trait characteristic, among others. With the identification, the content placement component **140** can use the device attribute, the application attribute, or the trait characteristic identified from the audio data packet as the content selection parameters.

In addition, the content placement component **140** can determine a content spot parameter for each content spot **148** included in the audio recording **146** associated with the request of the input audio signal. The content spot parameter

can be used to value the content spot **148**, and can be proportional to the measured or estimated number of views of the audio recording **146** or supplemental audio content inserted into the content spot **148**, or a combination thereof. The number of listenings of the audio recording **146** itself and the number of listenings of the supplemental audio content insert into the content spot **148** of the audio recording **146** can be instrumented from previous servings of the audio recording **146** across a multitude of client devices **104**. For example, the number of listenings of the audio recording **145** can be measured from the instrumenting the playback of the audio recording **145** via multiple instances of the digital assistant application **110** across different client devices **104**. The number of listenings of supplemental audio content inserted into one content spot **148** of the audio recording **146** can be measured from detecting a number of predefined interaction events detected across multiple client devices **104** that have been provided with the audio recording **146**. The predefined interaction event can include, for example: a subsequent voice query detected via the microphone **154** of the client device **104** including words related to the supplemental audio content or a set of interactions on an information resource associated with the content provider **108** associated with the supplemental audio content. From the measured number, the estimated number of listenings of the audio recording **146** and of the supplemental audio content insert into the content spot **148** can be calculated (e.g., via reconstruction, trend estimation, or extrapolation techniques). Both the measured numbers and the estimated numbers can be determined and maintained by a counter of the data processing system **102**.

In determining the numbers, the content placement component **140** can establish at least one prediction model for estimating the number of listenings of the audio recordings **146** and the number of listenings of the supplemental audio content inserted into the content spot **148**. The prediction model can be generated in accordance with any number of machine learning algorithms or models, such as a regression model (e.g., linear or logistic), a support vector machine, an artificial neural network (ANN), a random forest classifier, a Bayesian statistical model, or a k-nearest neighbor algorithm, among others. The prediction model can be established using a training dataset maintained on the data repository **124** or **144**. The training dataset can include previous or sample measurements on the number of listenings of other audio recordings **146** and number of listenings of supplemental audio content inserted into the audio recordings **146** at various content spots **148**. In addition, the training dataset can include one or more characteristics of the audio recordings **146** and the content spots **148** themselves, for example: a length of each audio recording **146**, a length of the content spot **148** in the audio recording **146**, a time at which the content spot **148** is defined within the audio recording **148**, a topical category of the audio recording **146**, and a topical category of the supplemental audio content inserted into the content spot **148**, among others, The training dataset can also include data regarding the listeners of the audio recordings **146**, such as: the device attribute, the application attribute, or the trait characteristic, among others. Using the training dataset, the content placement component **140** can train the prediction model in accordance with the type of machine learning algorithm or model (e.g., until convergence). Upon training, the prediction model can be used to determine a predicted (or estimated) number of listenings of the audio recording **146** and the number of listenings of the supplemental audio content to be inserted into any of the content spots **148** within the audio recording **146**.

To determine the content spot parameter for the content spot **148**, the content placement component **140** can calculate, determine, or identify the number of listenings of the audio recording **146** across the multitude of client devices **104**. The content placement component **140** can identify the measured number of listenings of the audio recording **146** maintained by the counter. The content placement component **140** can identify the estimated number of listenings of the audio recording **146** (e.g., calculated using extrapolation). The content placement component **140** can also apply the audio recording **146** to determine a predicted number of listenings of the audio recording **146**. In applying, the content placement component **140** can identify various characteristics of the audio recording **146** (e.g., length and topical category). Upon applying, the content placement component **140** can determine or identify the predicted number of listenings outputted by the prediction model.

Furthermore, for each content spot **148** in the audio recording **146**, the content placement component **140** can calculate, determine, or identify the number of listenings of the supplemental audio content inserted into the content spot **148** across the multitude of client devices **104**. The supplemental audio content can correspond to one or more of the audio content items **150** maintained on the data repository **144**. The content placement component **140** can identify the measured number of listenings of the supplemental audio content inserted into the content spot **148** maintained by the counter. The content placement component **140** can identify the estimated number of listenings of the supplemental audio content inserted into the content spot **148** (e.g., calculated using extrapolation). The content placement component **140** can also apply the audio recording **146** to determine a predicted number of listenings of the supplemental audio content inserted into the content spot **148**. In applying, the content placement component **140** can identify various characteristics of the audio recording **146** (e.g., length and topical category) and the content spot **148** (e.g., time within the audio recording **146**). Upon applying, the content placement component **140** can identify the predicted number of listenings outputted by the prediction model.

Based on the measured, estimated, or predicted number of listenings, the content placement component **140** can calculate or determine the content spot parameter for the content spot **148** in the audio recording **146**. The content placement component **140** can determine one content spot parameter using the number of listenings for the audio recording **146**. The content placement component **140** can also determine another separate content spot parameter using the number of listenings for the supplemental audio content in the content spot **148** of the audio recording **146**. The content placement component **140** can also determine a single content spot parameter based on a combination of the number of listenings for the audio recording **146** and the number of listenings for the content spot **148** in the audio recording **146**. The combination can include, for example, a summation, an average, a weighted average, or a function, among others, or any combination thereof.

In selecting the supplemental audio content to insert into the content spot **148**, the content placement component **140** can run or perform a content placement process to select the audio content item **150** from a set of candidate audio content items **150**. In running the process, the content placement component **150** can request, retrieve, or identify a content submission parameter from each content provider **108**. The

content submission parameter can represent or indicate the valuing of the content spot **148** in the audio recording **146** by the corresponding content provider **108**. The content submission parameter can be associated with the audio content item **150** provided by the corresponding content provider **108**. The higher the value of the content submission parameter, the more likely the audio content item **150** of the content provider **108** may be selected. To retrieve the content submission parameters, the content placement component **150** can send a request for parameters to each content provider **108**. The request can include the content selection parameter and the content spot parameter. Upon receipt, each content provider **108** can determine or generate the content submission parameter based on the content selection parameter and the content spot parameter. Once generated, the content provider **108** can respond back with the content submission parameter to send to the data processing system **102**.

Using the one or more parameters, the content placement component **140** can select at least one of the audio content items **150** to insert into the content spot **148** of the identified audio recording **146**. The content placement component **140** can select the audio content item **150** from the set of candidate audio content items **150** maintained on the data repository **144** based on the content selection parameter. For example, the content placement component **140** can find the audio content item **150** with specifications (e.g., device attribute, application attribute, and trait attributes) matching the content selection parameter. The content placement component **140** can also select the audio content item **150** based on the content spot parameter (in combination with the content selection parameter). For example, the content placement component **140** can identify a subset of audio content items **150** with a categorical topic matching an interest indicated by the trait attribute and with the same length as the content spot **148**. In this example, from the subset, the content placement component **140** can select one audio content item **150** with the highest predicted number of listenings for supplemental audio content for insertion into the audio recording **146** at the content spot **148**.

In selecting the content item **150**, the content placement component **140** can also use the content submission parameter, and can continue with the content placement process with the receipt of the content submission parameters. The content placement component **140** can rank the content submission parameters received from the various content providers **108**. From the ranking, the content placement component **140** can identify the content provider **108** with the highest content submission parameter. With the identification, the content placement component **140** can identify or select the audio content item **150** from the content provider **108** with the highest content submission parameter in the ranking. Any combination of the content selection parameter, the content spot parameter, or the content submission parameter can be used to identify or select the audio content item **150** to insert into the content spot **148** of the audio recording **146**. The content placement component **140** can repeat the process of selecting one audio content item **150** for each of the content spots **148** defined for the audio recording **146**.

The direct action handler component **120** of the digital assistant application **110** can insert the audio content item **150** selected by the content placement component **115** into the content spot **148** of the audio recording **146**. With the selection of the audio content item **150** form the data repository **144**, the direct action handler component **120** can access the data repository **144** to identify the audio recording **146** identified by the NLP component **116**. For example, the direct action handler component **120** can retrieve the one or more audio files corresponding to the audio recording **146** generated by the content publisher **106** and identified by the NLP component **116**. Upon identification, the direct action handler component **120** can identify the content spot **148** in the audio recording **146** for which the audio content item **150** is selected. The direct action handler component **120** can add, embed, or insert the audio content item **150** into the content spot **148** at the time defined by the corresponding content spot marker. For example, the direct action handler component **120** can delete or null the audio content from the audio recording **146** during the time window defined by the content spot marker for the content spot **148**. Upon removal, the direct action handler component **120** can overlay the selected audio content item **150** into the time window of the content spot **148** within the audio recording **146**. In inserting the audio content item **150**, the direct action handler component **120** can perform one or more signal processing algorithms to convert the supplemental audio content for compatibility with the remainder of the audio recording **146**. The signal processing algorithms can include, for example, various audio mixing techniques, such as equalization, compression, and balancing, among others. The direct action handler component **120** can insert all the audio content items **150** selected for the content spots **148** of the audio recording **146**. With the insertion of the audio content item **150**, the direct action handler component **120** can cache or store the audio recording **146** (e.g., as one or more edited audio files) for provision to the client device **104**.

The direct action handler component **120** can generate at least one action data structure to carry out the request indicated in the input audio signal detected by the microphone **154** on the client device **104**. The action data structure can be generated in accordance with the HyperText Transfer Protocol (HTTP), among others. For example, the action data structure can be included in a body (or payload) of an HTTP response, along with other data, to complete the request specified in the input audio signal. The direct action handler component **120** can invoke the response selector component **122** format or generate the direct action structure in accordance with the data stored in the data repository **124**, such as the regular expression **126**, the parameters **128**, the policies **130**, the response data **132**, and the templates **134**, among others. For example, the response selector component **122** can retrieve the template **134** from the data repository **124** to determine which fields to include in the action data structure. The response selector component **122** can retrieve content from the data repository **124** to obtain information for the fields of the data structure for a response to the request for the audio content. The response selector component **122** (or the direct action handler component **120**) can include one or more words in a message to be included in the action data structure as a response to the request for audio content. For example, the response message can include the words "Found podcast. Downloading from Talk Show PQR."

In generating the action data structure, the direct action handler component **120** can include the audio recording **146** with one or more audio content items **150** inserted into the content spots **148**. The direct action handler component **120** can insert the one or more audio files corresponding to the audio recording **146** with the inserted audio content items **150** into the action data structure. The direct action handler component **120** can include an address (e.g., a URL address or a network address) referencing the audio recording **146** with the audio content items **150** into the action data

structure. The address can be used by the instance of the digital assistant application **110** on the client device **104** to retrieve or download the audio recording **146** with the audio content items **150** inserted from the data repository **144**. The direct action handler component **120** can include the audio recording **146** as part of the body of the HTTP response that includes the action data structure. Upon insertion, the direct action handler component **120** can provide, send, or transmit the action data structure to the instance of the digital assistant application **110** on the client device **104**. The transmission of the action data structure can involve or correspond to uploading of the audio recording **146** onto the client device **104**, without streaming the audio recording **146** to the client device **104**. For example, rather than providing chunks of the audio recording **146** via streaming, the direct action handler component **120** can transmit the files corresponding to the audio recording **146** for downloading onto the client device **104**.

With the transmission, the instance of the digital assistant application **110** on the client device **104** can receive the action data structure including the audio recording **146** with the inserted audio content items **150**. The receipt of the action data structure can involve or correspond to retrieval or downloading of the audio recording **146** itself by the digital assistant application **110**, rather than streaming of the audio content included in the audio recording **146**. The digital assistant application **110** on the client device **104** can parse the action data structure to extract, retrieve, or identify the audio recording **146**. For example, when the audio file is included, the digital assistant application **110** can pull the one or more audio files corresponding to the audio recording **146** from the body of the HTTP response. When the address to the audio recording **146** with the inserted audio content items **150** are included, the digital assistant application **110** can retrieve and download the audio recording **146** using the address onto the client device **104** (e.g., on the hard drive or memory). Subsequent to retrieval, the digital assistant application **110** can present the audio recording **146** with the inserted audio content items **150** at the content spots **148** via the speaker **152** of the client device **104**. For example, the digital assistant application **110** on the client device **104** can include a media player component to handle playback the downloaded audio content of the audio recording **146** via the speaker **152**.

The audio signal generator component **118** of the digital assistant application **110** (on the data processing system **102** or the client device **104**) can parse the action data structure to identify words for the response. The audio signal generator component **118** can generate an output audio file based on the one or more words of response phrase in the response to the request indicated in the input audio signal. The audio signal generator component **118** can play (e.g., via the speaker **152**) the output audio file of the one or more words of the response phrase. For example, the audio signal generator component **118** can generate an output audio file including the words "Found podcast. Downloading from Talk Show PQR." The digital assistant application **110** on the client device **104** can also display the one or more words of the response phrase.

The conversion detection component **142** executing on the data processing system **102** can monitor for one or more interaction events occurring on the client device **104** subsequent to provision of the audio recording **146** with the inserted audio content items **150**. The interaction events can include another input audio signal, a click event, a screen touch event, or a playback initiation event, a playback pause event, or among others detected via the client device **104**. The conversion detection component **142** can use any number of techniques to monitor for interaction events. For example, the conversion detection component **142** can use the identifier **136** (e.g., in the form of the session identifier) to access the interaction events received via a web application (e.g., a web browser). The conversion detection component **142** can use the identifier **136** (e.g., in the form of the device identifier or account identifier) to access the interaction events detected via an application programming interface (API) for the digital assistant application **110** on the client device **104**. The API can define function calls for retrieval of at least pre-defined interaction events detected on the digital assistant application **110** on the client device **104**. For example, the digital assistant application **110** can send an indication to the conversion detection component **142** via the API upon detection of a playback initiation and subsequent playback completion events. The conversion detection component **142** can access a location within the playback of the audio recording **146** by the digital assistant application **110** via the API. The location can indicate a point of time within the audio recording **146** is playing via the client device **104**.

By monitoring, the conversion detection component **142** can maintain and update a counter for the number of listenings of the audio recording **146** across the multitude of client device **104**. The counter can indicate the measured number of listenings to the audio recording **146**, and may be used by the content placement component **140** in determining the content spot parameter. To maintain the counter, the conversion detection component **142** can monitor the location within the playback of the audio recording **146** (e.g., via the API for the digital assistant application **110**). The conversion detection component **142** can commence monitoring of the playback in response to detecting a playback initiation event from the digital assistant application **110** on the client device **104**. The conversion detection component **142** can determine whether the location matches a predefined duration of the audio recording **146**. The predefined duration can correspond to an entire length in time of the audio recording **146** or a percentage of the entire length (e.g., 75-95%) of the audio recording **146** as specified by the content publisher **106**.

The conversion detection component **142** can compare the monitored location with the predefined duration. By comparing, the conversion detection component **142** can determine whether the playback of the audio recording **146** has completed on the digital assistant application **110** on the client device **104**. In response to determining that the location matches the predefined duration, the conversion detection component **142** can determine that the playback of the audio recording **146** is completed. Furthermore, the conversion detection component **142** can increment the counter for the number of listenings of the audio recording **146**. The conversion detection component **142** can also use the detection of the playback complete event to increment the counter, independent of the monitored location. Conversely, in response to the determining that the location does not match the predefined duration, the conversion detection component **142** can continue to monitor the location of the playback.

In addition, the conversion detection component **142** can maintain a counter for the number of listenings of the supplemental audio content inserted into the content spot **148** of the audio recording **146** across the multitude of client devices. The counter can indicate the measured number of listenings to the supplemental audio content (e.g., the selected audio content item **150** or another audio content

item **150**) inserted into the content spot **148** of the audio recording **146**. The counter may be used by the content placement component **140** in determining the content spot parameter. To maintain the counter for the number of listenings of the audio content item **150**, the conversion detection component **142** can compare the one or more detected interaction events with a set of predefined interaction events. The set of interaction events can be predefined for the audio content item **150** inserted into the content spot **148** of the audio recording **148**. The set of interaction events can specified by the content provider **108** for the audio content item **150** as corresponding to a conversion, and can include one or more events expected for the conversion. For example, the set of interaction events for the audio content item **150** can include acquisition of an input audio signal via the microphone **154** of the client device **104** including a name of the content provider **108**.

From the comparison, the conversion detection component **142** can determine whether the detected interaction events match the predefined interaction events for the audio content item **150**. In response to determining a match between the detected and predefined interaction events, the conversion detection component **142** can determine that the supplemental audio content inserted into the content spot **148** of the audio recording **146** is listened to. Furthermore, the conversion detection component **142** can increment the counter for the number of listenings of the supplemental audio content inserted into the content spot **148** of the audio recording **146**. The conversion detection component **142** can also maintain and update a counter for the number of listenings of the audio content item **150** itself. On the other hand, in response to determining a lack of the match between the detected and predefined interaction events, the conversion detection component **142** can determine that the supplemental audio content inserted into the content spot **148** did not result in a conversion. In addition, the conversion detection component **142** can sustain a value of the counter for the number of listenings of the supplemental audio content inserted into the content spot **148** of the audio recording **146**.

Based on the measured numbers, the conversion detection component **142** can calculate or determine an expected number of listenings of the audio recording **146** and an expected number of listenings of the supplemental audio content inserted into each content spot **148** of the audio recording **146**. The conversion detection component **142** can access the counters to identify the measured number of listenings of the audio recording **146** and the measured number of listenings of the supplemental audio content inserted into the content spot **148** of the audio recording **146**. With the identification, the conversion detection component **142** can apply any number of techniques, such as regression, reconstruction, trend estimation, or extrapolation, to determine the expected number of listenings. For example, the conversion detection component **142** can identify the number of measured listenings of the audio recording **146** (or the supplemental audio content at one of the content spots **148**) over time. The conversion detection component **142** can construct a polynomial function to characterize the number of measured listenings. In accordance with the constructed function, the conversion detection component **142** can determine the expected number of listenings of the audio recording **146** at a future time point.

In this manner, the audio content items **150** presented with the audio recording **146** can have higher relevance to the user of the digital assistant application **110** of the client device **104** that made the initial request. With the increased relevance, the likelihood of subsequent interaction in connection with the audio content item **150** can increase. In addition, the chances that subsequent voice commands to the digital assistant application **110** are incongruous with prior voice commands or the audio recording **146** can be lowered. The inclusion of such audio content items **150** into the audio recording **146** can thus improve the human-interaction interaction between the user and the digital assistant application **110** on the client device **104**, while conversing computing resources and saving network bandwidth.

FIG. **2**, among others, depicts a sequence diagram of an example data flow **200** to insert supplemental audio content into primary audio content in the system illustrated in FIG. **1**. The data flow **200** can be implemented or performed by the system **100** described above in conjunction with FIG. **1** or system **500** detailed below in conjunction with FIG. **5**. The data flow **200** can include communications in the form of packets (e.g., HTTP messages) among the data processing system **102**, the client device **104**, the content publisher **106**, the content provider **108**, the speaker **152**, and the microphone **154**, among others.

An instance of the digital assistant application **110** on the client device **104** can detect audio signal **205** via the microphone **156**. The digital assistant application **110** can perform initial processing on the audio signal **205** to generate a data packet **210** (sometimes referred herein as an audio data packet). The data packet **210** can include the input audio signal **205** itself or one or more string identified from the audio signal **205** using natural language processing techniques. The client device **104** can send the data packet **210** to a remote instance of the digital assistant application **110** on the data processing system **102**.

Meanwhile, the data processing system **102** can receive an audio file **215** from the content publisher **106**. The audio file **215** can be an instance of the audio recording **146**, and can include primary audio content generated by the content publisher **106**. The audio file **215** can be received with a content spot marker defining time windows within the primary audio content of the audio file **215** in which to insert the supplemental audio content. Upon receipt, the data processing system **102** can store and maintain the audio file **215** onto the data repository **144**.

The instance of the digital assistant application **110** on the data processing system **102** can receive the data packet **210** from the client device **104**. Upon receipt, the digital assistant application **110** can parse the input audio signal included in the data packet **210** to identify one or more words. With the identification, the digital assistant application **110** can determine that the words correspond to a request for audio content form one of the content publishers **106**. In response to the determination, the digital assistant application **110** can identify the audio file **210** from the specified content publisher **106**. In addition, the digital assistant application **110** can invoke a content placement process (e.g., via the content placement component **140**).

In performing the processing, the data processing system **102** can determine a content selection parameter for the client device **104** making the request and can determine a content spot parameter for the content spot in the audio file **215**. The data processing system **102** can also send a fetch request **220** to content providers **108** for content placement parameter. Upon receipt, each content provider **108** can generate a value parameter **225** (sometimes referred herein as a content submission parameter). The value parameter **225** can indicate a valuing of the content spot **148** within the audio file **215** by the corresponding content provider **108**. Once generated, each content provider **108** can transmit the

value parameter **225** to the data processing system **102**. Using the various parameters, the data processing system **102** can select one audio content item **150** to include into the content spot **148** of the audio file **215** in accordance with the content placement process.

With the selection of the audio content item **150**, the instance of the digital assistant application **110** on the data processing system **102** can insert the audio content item **150** into the content spot **148** of the audio file **215**. The digital assistant application **110** can also generate an action data structure **230** to package or include the audio file **215** with the audio content item **150** inserted into the content spot **148**. Upon generation, the digital assistant application **110** on the data processing system **102** can transmit the action data structure **230** to the instance of the digital assistant application **110** on the client device **104**. The transmission of the audio file **215** can be a download onto the client device **104**, rather than a stream. In turn, the digital assistant application **110** on the client device **104** can receive and parse the action data structure **230** to identify the audio file **215** with the inserted audio content item **150**. With the identification, the digital assistant application **110** can convert the audio file **215** with the inserted audio content item **250** into an audio signal **235** for playback. The speaker **152** can output the audio signal **235** to present and playback the primary and supplemental audio content included in the audio file **215**.

FIG. **3**, among others, depicts an example client device **104** with request and response messages in presenting primary and supplemental audio content under configuration **300**. In the configuration **300**, the instance of the digital assistant application **110** running on the client device **104** can receive an input audio signal via the microphone **154**. The NLP component **116** can use natural language processing techniques to recognize one or more words in the input audio signal. The digital assistant application **110** can display the output of the natural language processing techniques as a textual content item **305**. The textual content item **305** can include the words "Download a podcast from Talk Show A" parsed from the input audio signal acquired via the microphone **154**. The NLP component **116** can also use the natural language processing techniques to recognize that the words parsed from the input audio signal correspond to a request for audio content. The NLP component **116** can identify the content publisher **106** (e.g., "Talk Show A") associated with the request. The digital assistant application **110** can display the results of the carrying out of the request with a textual content item **310**. The textual content item **310** can include the words "Latest Podcast from Talk Show A," and can include a media player interface **315**. The media player interface **315** can include, for example as depicted, a pause button, a play button, and a progress bar, among others.

In fulfilling the request as indicated in the input audio signal, the NLP component **116** can identify one of the audio recordings **146** associated with the content publisher **106** from the data repository **144**. The audio recording **146** can include primary audio content **320** and at least one content spot marker defining the content spot **148**. The content spot **148** can define a time window within to insert supplemental audio content **325**. To insert the supplemental audio content **325**, the content placement component **140** can determine a content selection parameter for the client device **104** and a content spot parameter for the content spot **148**. In addition, the content placement component **140** can gather content submission parameters from various content providers **108** associated with candidate audio content items **150**. The content placement component **140** can run a content placement process using the set of parameters to select one of the audio content items **150** to insert into the content spot **148**. Once inserted, the data processing system **102** can provide the audio recording **146** with the audio content item **150** for downloading onto the client device **104** and playback via the digital assistant application **110** on the client device **104**. Upon receipt of an interaction with the play button on the media player interface **315**, the digital assistant application **110** can playback the audio recording **146** with the audio content item **150**.

FIG. **4**, among others, depicts a flow diagram of an example method **400** to insert supplemental audio content into primary audio content via digital assistant applications. The method **500** can be implemented or executed by the system **100** described above in conjunction with FIGS. **1-3** or system **500** detailed below in conjunction with FIG. **5**. The method **400** can include parsing an input audio signal (**405**). An instance of a digital assistant application **110** on a client device **104** can receive the input audio signal acquired via a microphone **154**. The digital assistant application **110** can perform initial processing and package the input audio signal into an audio data packet to send to the data processing system **102**. An instance of the digital assistant application **110** on the data processing system **102** can receive the audio data packet from the client device **104**. An NLP component **116** can parse the audio data packet to identify the input audio signal. To process, the NLP component **116** can use natural language processing to identify one or more words in the input audio signal and can determine that the input audio signal corresponds to a request for audio content based on the recognized words.

The method **400** can include identifying an audio recording **146** (**410**). In response to determining that the input audio signal corresponds to the request for audio content, the NLP component **116** can identify the content provider **108** associated with the request. With the identification, the NLP component **116** can access the data repository **144** to identify the audio recording **146** belonging to the content publisher **106** indicated in the request. The data repository can be maintained by the record indexer component **138**, and can include audio recordings **146** from various content publishers **106**. The audio recording **146** can include primary audio content and at least one content spot **148** defined by a content spot marker for insertion of supplemental audio content.

The method **400** can include identifying a content selection parameter (**415**). A content placement component **140** on the data processing system **102** can determine the content spot parameter for the client device **104** in response to determining that the input audio signal corresponds to the request for content. The content placement component **140** can identify an identifier **136** (e.g., a device identifier, an account identifier, or a session or cookie identifier) associated with the digital assistant application **110** on the client device **104** that made the request. The content placement component **140** can also identify data associated with the audio data packet, such as a device attribute, an application attribute, or a trait characteristic, among others. The content placement component **140** can use the identifier **136** and the associated data as the content selection parameter.

The method **400** can include determining a content spot parameter (**420**). To determine the content spot parameter for one of the content spots **148**, the content placement component **140** can identify a number of listenings of the identified audio recording **146**. The content placement component **140** can also identify the number of listenings of the supplemental audio content inserted into the content spot

148 of the audio recording 146. Each number of listenings can be measured using a counter, estimated using extrapolation, or predicted using a machine learning model. Once identified, the content placement component 140 can calculate or determine the content spot parameter based on the numbers of listenings.

The method 400 can include selecting an audio content item 150 (425). Using the content selection parameter and the content spot parameter, the content placement component 140 can select one of the audio content items 150 to insert into the content spot 148 of the audio recording 146. The content placement component 140 can also perform a content placement process to select the audio content item 150. In running the process, the content placement component 140 can fetch a content submission parameter from each content provider 108 associated with one of the candidate audio content items 150. In addition to the content selection parameter and the content spot parameter, the content placement component 140 can also use the content submission parameter in selecting the audio content item 150 for insertion.

The method 400 can include inserting the audio content item 150 into the audio recording 146 (430). A direct action handler component 120 of the digital assistant application 110 can insert the selected audio content item 150 into the content spot 148 of the audio recording 146. To insert, the direct action handler component 120 can identify the content spot 148 defined by the content spot marker for the audio recording 146. Once identified, the direct action handler component 120 can overlay or insert the selected audio content item 150 into the content spot 148 of the audio recording 146. The direct action handler component 120 can also perform additional signal processing techniques to facilitate the insertion of the audio content item 150 into the audio recording 146.

The method 400 can include transmitting an action data structure (435). The direct action handler component 120 can generate the action data structure to include the audio recording 146 with the inserted audio content item 150. The generation of the action data structure can be in accordance with HyperText Transfer Protocol (HTTP), with the action data structure included as part of a body of an HTTP response. Once generated, the direct action handler component 120 can send or provide the action data structure to the instance of the digital assistant application 110 on the client device 104. In providing the action data structure, the direct action handler component 120 can provide the audio recording 146 with the inserted audio content item 150 as a download, rather than streaming. Upon receipt, the instance of the digital assistant application 110 on the client device 104 can commence playback of the audio recording 146 with the inserted audio content item 150.

The method 400 can include monitoring for playback and interactions (440). A conversion detection component 142 on the data processing system 102 can monitor for interactions and playback, subsequent to the transmission of the action data structure. The conversion detection component 142 can use any number of techniques to monitor, such as use of a session cookie or accessing the client device 104 via an application programming interface for the digital assistant application 110. Using the detected interactions and playback, the conversion detection component 142 can maintain and update a counter for the number of listenings for the audio recording 146. The conversion detection component 142 can maintain and update a counter for the number of listenings for the supplemental audio content inserted into the content spot 148 of the audio recording 146.

FIG. 5 is a block diagram of an example computer system 500. The computer system or computing device 500 can include or be used to implement the system 100 or its components such as the data processing system 102. The computing system 500 includes a bus 505 or other communication component for communicating information and a processor 510 or processing circuit coupled to the bus 505 for processing information. The computing system 500 can also include one or more processors 510 or processing circuits coupled to the bus for processing information. The computing system 500 also includes main memory 515, such as a random access memory (RAM) or other dynamic storage device, coupled to the bus 505 for storing information and instructions to be executed by the processor 510. The main memory 515 can be or include the data repository 124 or 144. The main memory 515 can also be used for storing position information, temporary variables, or other intermediate information during execution of instructions by the processor 510. The computing system 500 may further include a read-only memory (ROM) 520 or other static storage device coupled to the bus 505 for storing static information and instructions for the processor 510. A storage device 525, such as a solid state device, magnetic disk or optical disk, can be coupled to the bus 505 to persistently store information and instructions. The storage device 525 can include or be part of the data repositories 124 or 144.

The computing system 500 may be coupled via the bus 505 to a display 535, such as a liquid crystal display or active matrix display, for displaying information to a user. An input device 530, such as a keyboard including alphanumeric and other keys, may be coupled to the bus 505 for communicating information and command selections to the processor 510. The input device 530 can include a touch screen display 535. The input device 530 can also include a cursor control, such as a mouse, a trackball, or cursor direction keys, for communicating direction information and command selections to the processor 510 and for controlling cursor movement on the display 535. The display 535 can be part of the data processing system 102, the client devices 104, or other components of FIG. 1, for example.

The processes, systems and methods described herein can be implemented by the computing system 500 in response to the processor 510 executing an arrangement of instructions contained in main memory 515. Such instructions can be read into main memory 515 from another computer-readable medium, such as the storage device 525. Execution of the arrangement of instructions contained in main memory 515 causes the computing system 500 to perform the illustrative processes described herein. One or more processors in a multi-processing arrangement may also be employed to execute the instructions contained in main memory 515. Hard-wired circuitry can be used in place of or in combination with software instructions together with the systems and methods described herein. Systems and methods described herein are not limited to any specific combination of hardware circuitry and software.

Although an example computing system has been described in FIG. 5, the subject matter including the operations described in this specification can be implemented in other types of digital electronic circuitry or in computer software, firmware, or hardware, including the structures disclosed in this specification and their structural equivalents, or in combinations of one or more of them.

For situations in which the systems discussed herein collect personal information about users, or may make use of personal information, the users may be provided with an opportunity to control whether programs or features that

may collect personal information (e.g., information about a user's social network, social actions, or activities; a user's preferences; or a user's location), or to control whether or how to receive content from a content server or other data processing system that may be more relevant to the user. In addition, certain data may be anonymized in one or more ways before it is stored or used, so that personally identifiable information is removed when generating parameters. For example, a user's identity may be anonymized so that no personally identifiable information can be determined for the user, or a user's geographic location may be generalized where location information is obtained (such as to a city, postal code, or state level), so that a particular location of a user cannot be determined. Thus, the user may have control over how information is collected about him or her and used by the content server.

The subject matter and the operations described in this specification can be implemented in digital electronic circuitry or in computer software, firmware, or hardware, including the structures disclosed in this specification and their structural equivalents, or in combinations of one or more of them. The subject matter described in this specification can be implemented as one or more computer programs, e.g., one or more circuits of computer program instructions, encoded on one or more computer storage media for execution by, or to control the operation of, data processing apparatuses. Alternatively or in addition, the program instructions can be encoded on an artificially generated propagated signal, e.g., a machine-generated electrical, optical, or electromagnetic signal that is generated to encode information for transmission to suitable receiver apparatus for execution by a data processing apparatus. A computer storage medium can be, or be included in, a computer-readable storage device, a computer-readable storage substrate, a random or serial-access memory array or device, or a combination of one or more of them. While a computer storage medium is not a propagated signal, a computer storage medium can be a source or destination of computer program instructions encoded in an artificially generated propagated signal. The computer storage medium can also be, or be included in, one or more separate components or media (e.g., multiple CDs, disks, or other storage devices). The operations described in this specification can be implemented as operations performed by a data processing apparatus on data stored on one or more computer-readable storage devices or received from other sources.

The terms "data processing system," "computing device," "component," or "data processing apparatus" encompass various apparatuses, devices, and machines for processing data, including, by way of example, a programmable processor, a computer, a system on a chip, or multiple ones, or combinations of the foregoing. The apparatus can include special-purpose logic circuitry, e.g., an FPGA (field-programmable gate array) or an ASIC (application-specific integrated circuit). The apparatus can also include, in addition to hardware, code that creates an execution environment for the computer program in question, e.g., code that constitutes processor firmware, a protocol stack, a database management system, an operating system, a cross-platform runtime environment, a virtual machine, or a combination of one or more of them. The apparatus and execution environment can realize various different computing model infrastructures, such as web services, distributed computing and grid computing infrastructures. The components of system **100** can include or share one or more data processing apparatuses, systems, computing devices, or processors.

A computer program (also known as a program, software, software application, app, script, or code) can be written in any form of programming language, including compiled or interpreted languages, declarative or procedural languages, and can be deployed in any form, including as a stand-alone program or as a module, component, subroutine, object, or other unit suitable for use in a computing environment. A computer program can correspond to a file in a file system. A computer program can be stored in a portion of a file that holds other programs or data (e.g., one or more scripts stored in a markup language document), in a single file dedicated to the program in question, or in multiple coordinated files (e.g., files that store one or more modules, sub programs, or portions of code). A computer program can be deployed to be executed on one computer or on multiple computers that are located at one site or distributed across multiple sites and interconnected by a communication network.

The processes and logic flows described in this specification can be performed by one or more programmable processors executing one or more computer programs (e.g., components of the data processing system **102**) to perform actions by operating on input data and generating output. The processes and logic flows can also be performed by, and apparatuses can also be implemented as, special purpose logic circuitry, e.g., an FPGA (field-programmable gate array) or an ASIC (application-specific integrated circuit). Devices suitable for storing computer program instructions and data include all forms of non-volatile memory, media and memory devices, including by way of example semiconductor memory devices, e.g., EPROM, EEPROM, and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto optical disks; and CD-ROM and DVD-ROM disks. The processor and the memory can be supplemented by, or incorporated in, special purpose logic circuitry.

The subject matter described herein can be implemented in a computing system that includes a back end component, e.g., as a data server, or that includes a middleware component, e.g., an application server, or that includes a front end component, e.g., a client computer having a graphical user interface or a web browser through which a user can interact with an implementation of the subject matter described in this specification, or a combination of one or more such back end, middleware, or front end components. The components of the system can be interconnected by any form or medium of digital data communication, e.g., a communication network. Examples of communication networks include a local area network ("LAN") and a wide area network ("WAN"), an inter-network (e.g., the Internet), and peer-to-peer networks (e.g., ad hoc peer-to-peer networks).

The computing system such as system **100** or system **500** can include clients and servers. A client and server are generally remote from each other and typically interact through a communication network (e.g., the network **112**). The relationship of client and server arises by virtue of computer programs running on the respective computers and having a client-server relationship to each other. In some implementations, a server transmits data (e.g., data packets representing a content item) to a client device (e.g., for purposes of displaying data to and receiving user input from a user interacting with the client device). Data generated at the client device (e.g., a result of the user interaction) can be received from the client device at the server (e.g., received by the data processing system **102** from the client devices **104**.

While operations are depicted in the drawings in a particular order, such operations are not required to be per-

formed in the particular order shown or in sequential order, and all illustrated operations are not required to be performed. Actions described herein can be performed in a different order.

The separation of various system components does not require separation in all implementations, and the described program components can be included in a single hardware or software product. For example, the NLP component **116** and the direct action handler component **120** can be a single component, app, or program, or a logic device having one or more processing circuits, or part of one or more servers of the data processing system **102**.

Having now described some illustrative implementations, it is apparent that the foregoing is illustrative and not limiting, having been presented by way of example. In particular, although many of the examples presented herein involve specific combinations of method acts or system elements, those acts and those elements may be combined in other ways to accomplish the same objectives. Acts, elements, and features discussed in connection with one implementation are not intended to be excluded from a similar role in other implementations.

The phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of "including," "comprising," "having," "containing," "involving," "characterized by," "characterized in that," and variations thereof herein, is meant to encompass the items listed thereafter, equivalents thereof, and additional items, as well as alternate implementations consisting of the items listed thereafter exclusively. In one implementation, the systems and methods described herein consist of one, each combination of more than one, or all of the described elements, acts, or components.

Any references to implementations, elements, or acts of the systems and methods herein referred to in the singular may also embrace implementations including a plurality of these elements, and any references in plural to any implementation, element, or act herein may also embrace implementations including only a single element. References in the singular or plural form are not intended to limit the presently disclosed systems or methods, their components, acts, or elements to single or plural configurations. References to any act or element being based on any information, act, or element may include implementations where the act or element is based at least in part on any information, act, or element.

Any implementation disclosed herein may be combined with any other implementation or embodiment, and references to "an implementation," "some implementations," "one implementation," or the like are not necessarily mutually exclusive and are intended to indicate that a particular feature, structure, or characteristic described in connection with the implementation may be included in at least one implementation or embodiment. Such terms as used herein are not necessarily all referring to the same implementation. Any implementation may be combined with any other implementation, inclusively or exclusively, in any manner consistent with the aspects and implementations disclosed herein.

References to "or" may be construed as inclusive so that any terms described using "or" may indicate any of a single, more than one, and all of the described terms. References to at least one of a conjunctive list of terms may be construed as an inclusive OR to indicate any of a single, more than one, and all of the described terms. For example, a reference to "at least one of 'A' and 'B'" can include only 'A', only 'B', as well as both 'A' and 'B'. Such references used in conjunction with "comprising" or other open terminology can include additional items.

Where technical features in the drawings, detailed description, or any claim are followed by reference signs, the reference signs have been included to increase the intelligibility of the drawings, detailed description, and claims. Accordingly, neither the reference signs nor their absence have any limiting effect on the scope of any claim elements.

The systems and methods described herein may be embodied in other specific forms without departing from the characteristics thereof. The foregoing implementations are illustrative rather than limiting of the described systems and methods. Scope of the systems and methods described herein is thus indicated by the appended claims, rather than the foregoing description, and changes that come within the meaning and range of equivalency of the claims are embraced therein.

What is claimed:

1. A system to insert supplemental audio content into primary audio content, comprising:

a natural language processor component executed on a data processing system to receive, from a client device, a request for an audio recording of a content provider, the audio recording having a content spot marker set by the content provider, the content spot marker specifying a content spot defining a time within the audio recording;

a content placement component executed on the data processing system to:

identifying, by a data processing system, a content selection parameter based on an identifier associated with the client device; and

selecting, by the data processing system, for the content spot of the audio recording, an audio content item from a plurality of audio content items based on the content selection parameter;

an action handler component executed on the data processing system to:

insert the audio content item into the content spot of the audio recording specified by the content spot marker;

generate an action data structure including the audio recording inserted with audio content item at the time defined by the content spot marker; and

transmit the action data structure to the client device to present the audio recording inserted with the audio content item at the content spot.

2. The system of claim **1**, comprising a conversion detection component executed on the data processing system to:

monitor, subsequent to the transmission of the action data structure, for an interaction event performed via the client device that matches a predefined interaction for the audio content item selected for insertion into the audio recording; and

determine, responsive to detection of the interaction event from the client device that matches the predefined interaction, that the audio content item inserted into the audio record is listened to via the client device.

3. The system of claim **1**, comprising a conversion detection component executed on the data processing system to:

monitor, subsequent to the transmission of the action data structure, a location within a playback of the audio recording inserted with the audio content item via an application programming interface (API) for an appli-

cation running on the client device using the identifier, the application to handle the playback of the audio recording; and

determine, responsive to the location matching a duration of the audio recording detected via the API, that the playback of the audio recording inserted with the audio content item is complete.

4. The system of claim **1**, comprising a conversion detection component executed on the data processing system to:

determine an expected number of client devices from which predefined interaction events for one of plurality of audio content items are to be detected subsequent to playback of the audio recording based on a measured number of client devices from which the predefined interaction events are detected; and

determine an expected number of client devices for which the playback of the audio recording inserted with one of the plurality of audio content items is to be completed based on a measured number of client devices from completion of the playback of the audio recording is detected.

5. The system of claim **1**, comprising the content placement component to:

establish, using training data, a prediction model to estimate numbers of client devices from which predefined interaction events for one of the plurality of content items are expected to be detected subsequent to playback of audio recordings inserted with one of the plurality of audio content items;

apply the prediction model to the audio recording with the content spot specified by the content spot marker to determine a content spot parameter corresponding to an expected number of client devices on which an interaction event is detected that matches a predefined interaction for each of the plurality of audio content items inserted into the audio recording at the content spot; and

select the audio content item of the content provider from the plurality of audio content items based on the content spot parameter for the content spot and a content submission parameter for each of the plurality of audio content items.

6. The system of claim **1**, comprising content placement component to:

identify a number of client devices on which an interaction event is detected that matches a predefined interaction for each of the plurality of audio content items inserted into the audio recording at the content spot;

determine a content spot parameter for the content spot defined in the audio recording based on the number of client devices on which the interaction event matches the predefined interaction; and

select the audio content item of the content provider from the plurality of audio content items based on the content spot parameter for the content spot and a content submission parameter for each of the plurality of audio content items.

7. The system of claim **1**, comprising the content placement component to:

identify a number of client devices for which playback of the audio recording inserted with one of the plurality of audio content items is completed;

determine a content spot parameter for the content spot defined in the audio recording based on the number of client devices for which the playback is completed; and

select the audio content item of the content provider from the plurality of audio content items based on the content spot parameter for the content spot and a content submission parameter for each of the plurality of audio content items.

8. The system of claim **1**, comprising the content placement component to:

Identify a plurality of content selection parameters including at least one of a device identifier, a cookie identifier associated with a session of the client device, an account identifier used to authenticate an application executing on the client device to playback to the audio recording, and a trait characteristic associated with the account identifier; and

select the audio content item from the plurality of audio content items using the plurality of content selection parameters.

9. The system of claim **1**, comprising the content placement component to identify the identifier associated with the client device via an application programming interface (API) with an application running on the client device.

10. The system of claim **1**, comprising:

the natural language processor component to receive audio data packet including the identifier associated with the client device, the identifier used to authenticate the client device to retrieve the audio recording; and

the content placement component to parse the audio data packet to identify the identifier as the content selection parameter.

11. The system of claim **1**, comprising a record indexer component to maintain, on a database, the audio recording of the content provider corresponding to at least one audio file to be downloaded on the client device for presentation.

12. The system of claim **1**, comprising the action handler component to transmit the action data structure to load the audio recording inserted with the audio content item at the content spot onto the client device without streaming.

13. A method of inserting supplemental audio content into primary audio content, comprising:

receiving, by a natural language processor component executed on a data processing system, a request from a client device for an audio recording of a content provider, the audio recording having a content spot marker set by the content provider, the content spot marker specifying a content spot defining a time within the audio recording;

identifying, by the data processing system, a content selection parameter based on an identifier associated with the client device;

selecting, by the data processing system, for the content spot of the audio recording, an audio content item from a plurality of audio content items based on the content selection parameter;

selecting, by the data processing system, for the content spot of the audio recording, an audio content item of a content provider from a plurality of audio content items using the content selection parameter;

inserting, by the data processing system, the audio content item into the content spot of the audio recording that defines the time specified by the content spot marker;

generating, by the data processing system, an action data structure including the audio recording inserted with audio content item at the time defined by the content spot marker; and

transmitting, by the data processing system, the action data structure to the client device to present the audio recording inserted with the audio content item at the content spot.

14. The method of claim 13, comprising:

monitoring, by the data processing system, subsequent to transmitting of the action data structure, for an interaction event performed via the client device that matches a predefined interaction for the audio content item selected for insertion into the audio recording; and

determining, by the data processing system, responsive to detecting of the interaction event from the client device that matches the predefined interaction, that the audio content item inserted into the audio record is listened to via the client device.

15. The method of claim 13, comprising:

monitoring, by the data processing system, subsequent to the transmission of the action data structure, a location within a playback of the audio recording inserted with the audio content item via an application programming interface (API) for an application running on the client device using the identifier, the application to handle the playback of the audio recording; and

determining, by the data processing system, responsive to the location matching a duration of the audio recording detected via the API, that the playback of the audio recording inserted with the audio content item is complete.

16. The method of claim 13, comprising:

establishing, by the data processing system, using training data, a prediction model to estimate numbers of client devices from which predefined interaction events for one of the plurality of content items are expected to be detected subsequent to playback of audio recordings inserted with one of the plurality of audio content items;

applying, by the data processing system, the prediction model to the audio recording with the content spot specified by the content spot marker to determine a content spot parameter corresponding to an expected number of client devices on which an interaction event is detected that matches a predefined interaction for each of the plurality of audio content items inserted into the audio recording at the content spot; and

selecting, by the data processing system, the audio content item of the content provider from the plurality of audio content items based on the content spot parameter for the content spot and a content submission parameter for each of the plurality of audio content items.

17. The method of claim 13, comprising:

identifying, by the data processing system, a number of client devices on which an interaction event is detected that matches a predefined interaction for each of the plurality of audio content items inserted into the audio recording at the content spot;

determining, by the data processing system, a content spot parameter for the content spot defined in the audio recording based on the number of client devices on which the interaction event matches the predefined interaction; and

selecting, by the data processing system, the audio content item of the content provider from the plurality of audio content items based on the content spot parameter for the content spot and a content submission parameter for each of the plurality of audio content items.

18. The method of claim 13, comprising:

identifying, by the data processing system, a number of client devices for which playback of the audio recording inserted with one of the plurality of audio content items is completed;

determining, by the data processing system, a content spot parameter for the content spot defined in the audio recording based on the number of client devices for which the playback is completed; and

selecting, by the data processing system, the audio content item of the content provider from the plurality of audio content items based on the content spot parameter for the content spot and a content submission parameter for each of the plurality of audio content items.

19. The method of claim 13, comprising:

identifying, by the data processing system, a plurality of content selection parameters including at least one of a device identifier, a cookie identifier associated with a session of the client device, an account identifier used to authenticate an application executing on the client device to playback to the audio recording, and a trait characteristic associated with the account identifier; and

selecting, by the data processing system, the audio content item from the plurality of audio content items using the plurality of content selection parameters.

20. The method of claim 13, comprising:

transmitting, by the data processing system, the action data structure to load the audio recording inserted with the audio content item at the content spot onto the client device without streaming.

* * * * *