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(54) **SIGNATURE RETRIEVAL AND MATCHING FOR MEDIA MONITORING**

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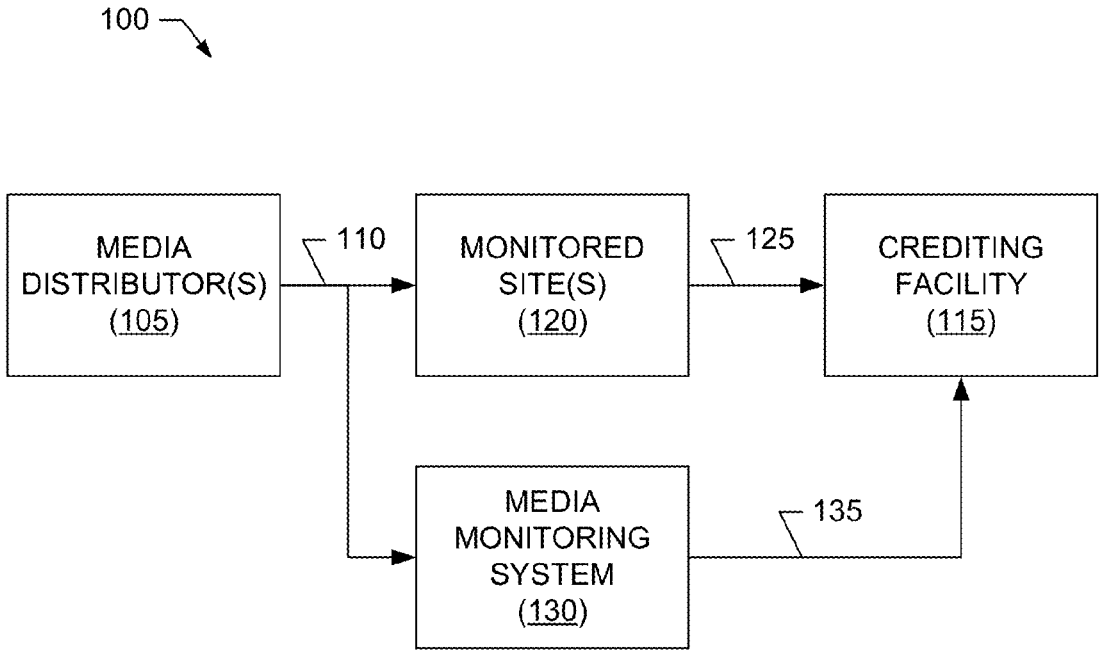
(57) **ABSTRACT**

Methods, apparatus and articles of manufacture for signature retrieval and matching for media monitoring are disclosed. An example apparatus includes a hash table populator to store hash keys of reference signatures included in a reference signature block associated with reference media in entries of a hash table, and store qualifier data in the entry of the hash table, the qualifier data including a timestamp, an offset, and an identifier associated with the reference signature of the hash key. The apparatus further including a block table populator to store a block table key corresponding to the reference signature block in the entry of a block table, the block table key including the timestamp and the identifier, and store the reference signature block, a preceding reference signature block and a subsequent reference signature block in the first entry of the block table. The apparatus further including a signature matcher to access the hash table and the block table to retrieve candidate reference signatures to compare with site signatures to identify the monitored media.



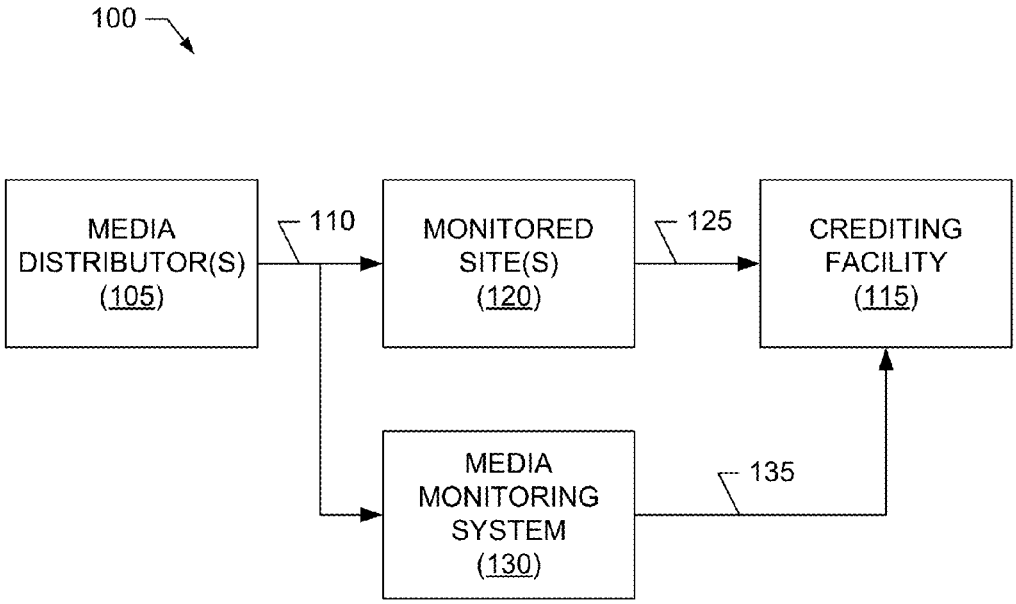

100
MEDIA DISTRIBUTOR(S) (105)
110
MONITORED SITE(S) (120)
125
CREDITING FACILITY (115)
MEDIA MONITORING SYSTEM (130)
135

FIG. 1

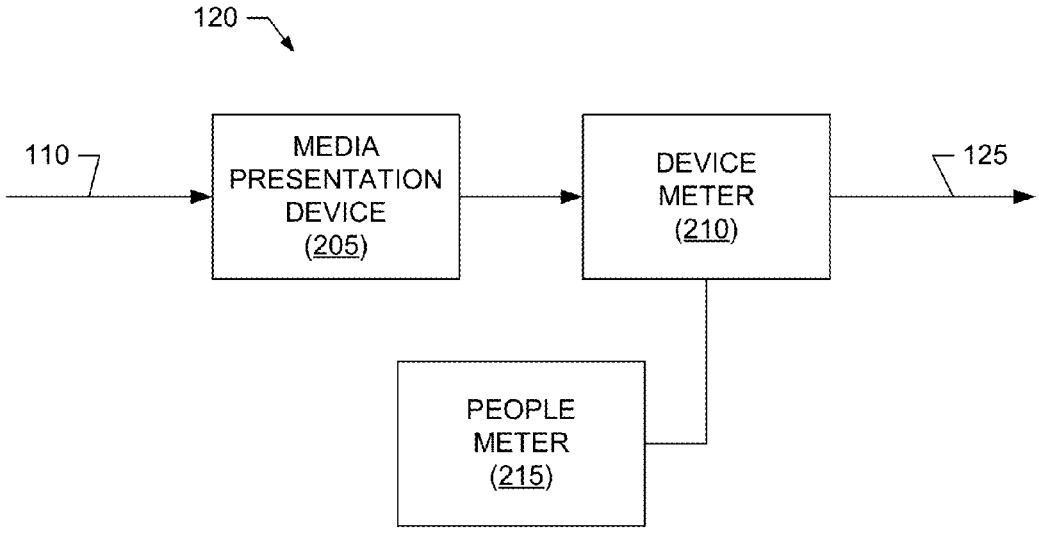

120
110
MEDIA PRESENTATION DEVICE (205)
DEVICE METER (210)
125
PEOPLE METER (215)

FIG. 2

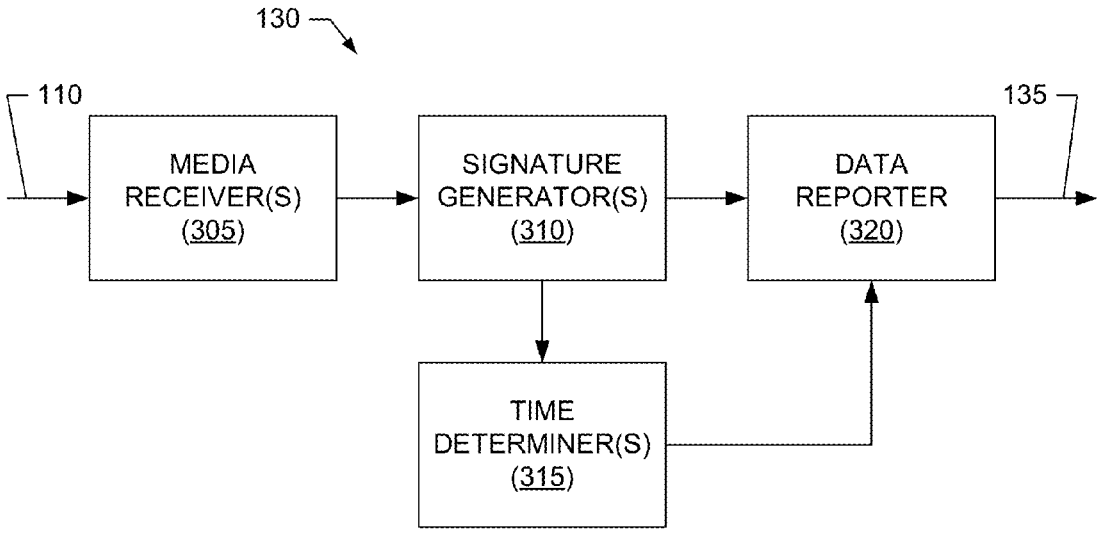

130
110
MEDIA RECEIVER(S) (305)
SIGNATURE GENERATOR(S) (310)
DATA REPORTER (320)
135
TIME DETERMINER(S) (315)

FIG. 3

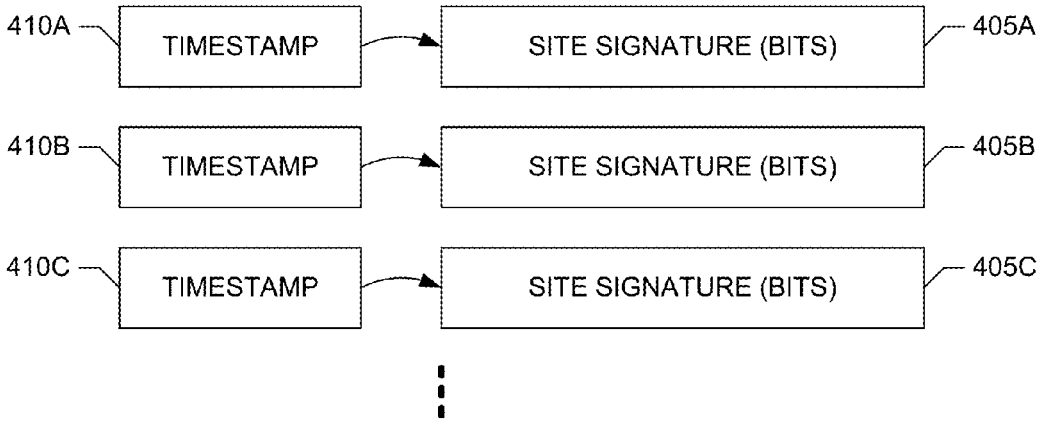

410A
TIMESTAMP
SITE SIGNATURE (BITS)
405A
410B
TIMESTAMP
SITE SIGNATURE (BITS)
405B
410C
TIMESTAMP
SITE SIGNATURE (BITS)
405C

FIG. 4

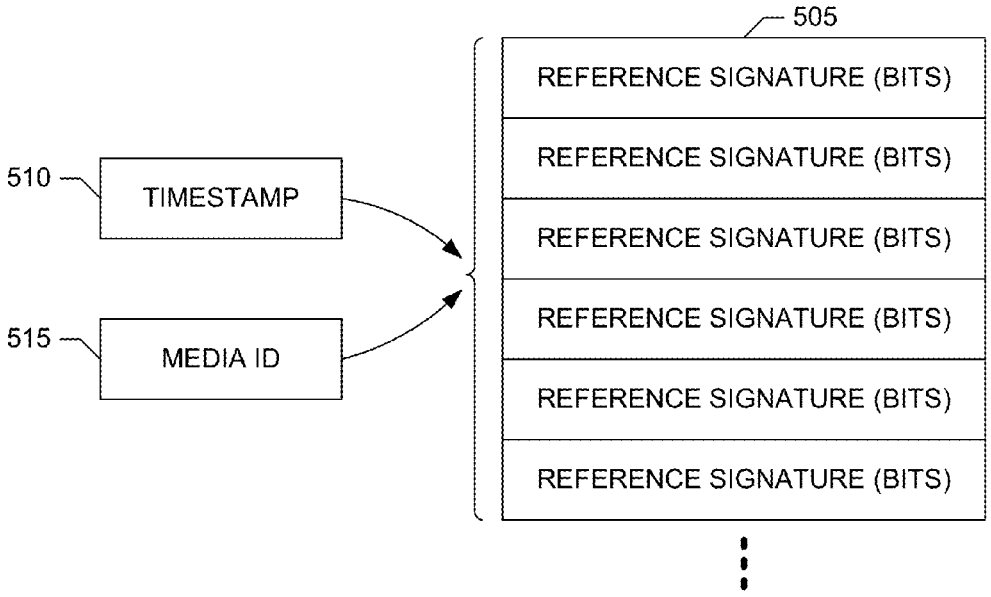

505
REFERENCE SIGNATURE (BITS)
REFERENCE SIGNATURE (BITS)
REFERENCE SIGNATURE (BITS)
REFERENCE SIGNATURE (BITS)
REFERENCE SIGNATURE (BITS)
REFERENCE SIGNATURE (BITS)
510
TIMESTAMP
515
MEDIA ID

FIG. 5

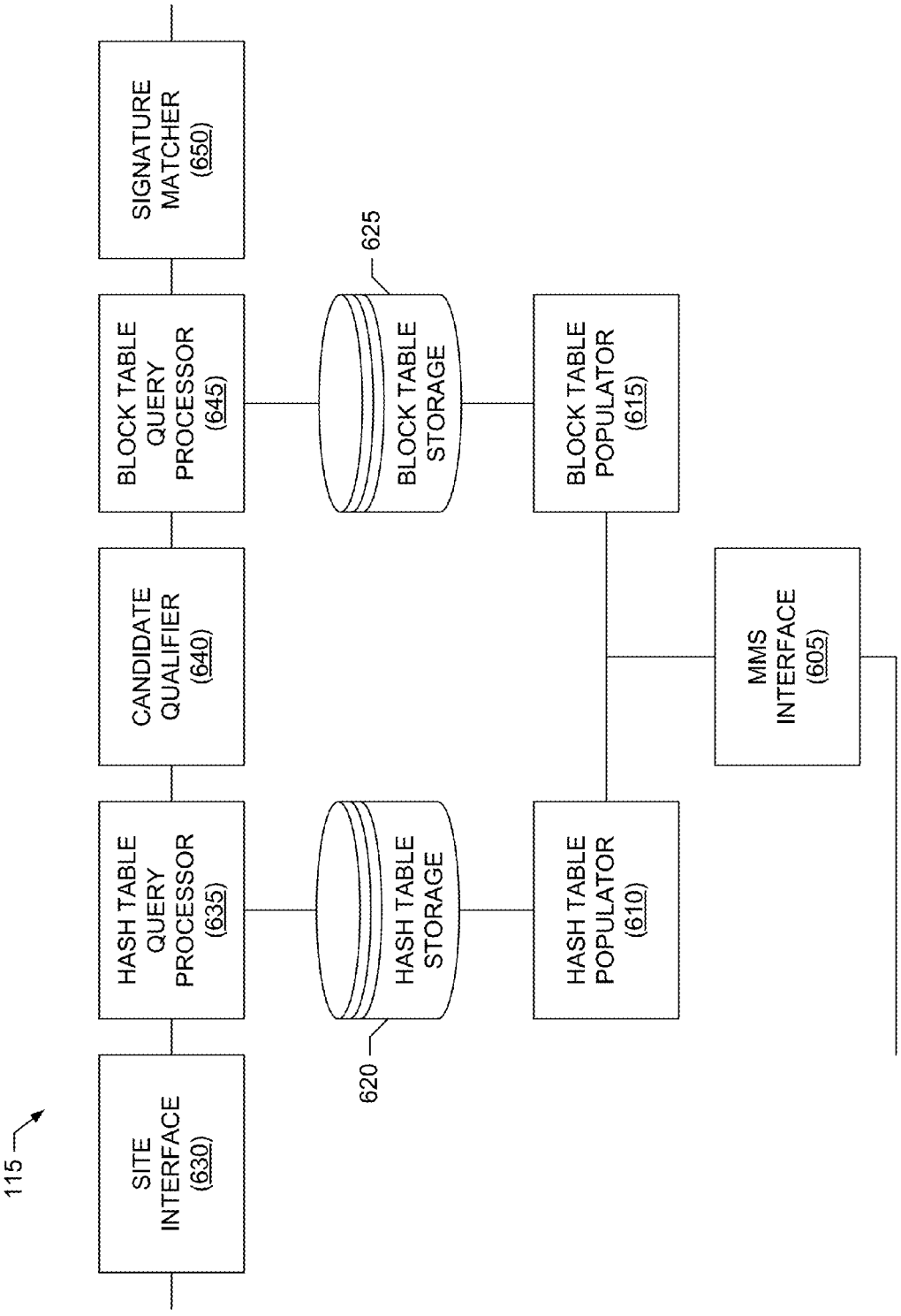

115
SITE INTERFACE (630)
HASH TABLE QUERY PROCESSOR (635)
CANDIDATE QUALIFIER (640)
BLOCK TABLE QUERY PROCESSOR (645)
SIGNATURE MATCHER (650)
620
HASH TABLE STORAGE
625
BLOCK TABLE STORAGE
HASH TABLE POPULATOR (610)
BLOCK TABLE POPULATOR (615)
MMS INTERFACE (605)

FIG. 6

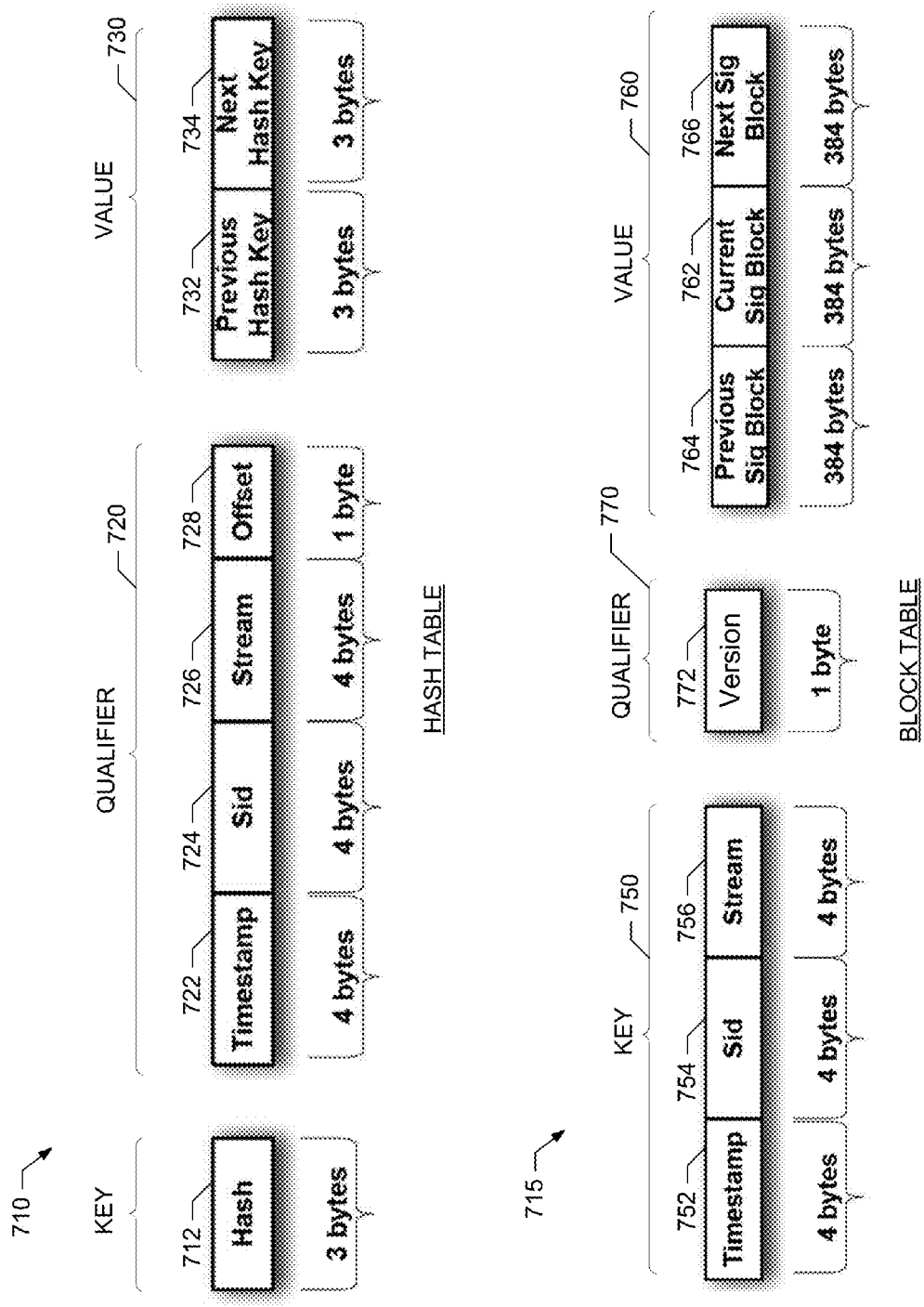
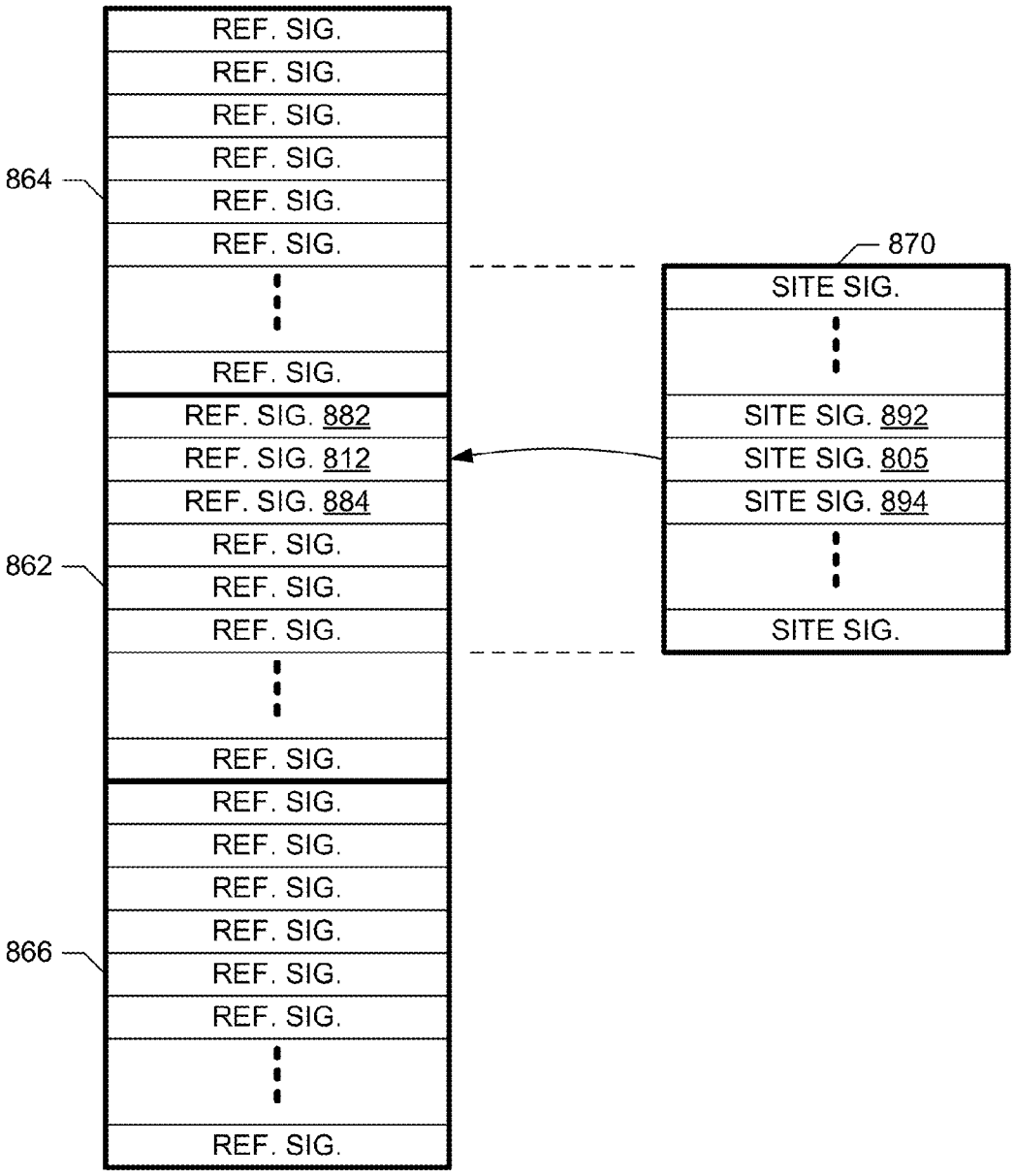

710
KEY
712
Hash
3 bytes
QUALIFIER
720
722
Timestamp
4 bytes
724
Sid
4 bytes
726
Stream
4 bytes
728
Offset
1 byte
VALUE
730
732
Previous Hash Key
3 bytes
734
Next Hash Key
3 bytes
HASH TABLE
715
KEY
750
752
Timestamp
4 bytes
754
Sid
4 bytes
756
Stream
4 bytes
QUALIFIER
770
772
Version
1 byte
VALUE
760
762
Current Sig Block
384 bytes
764
Previous Sig Block
384 bytes
766
Next Sig Block
384 bytes
BLOCK TABLE

FIG. 7


REF. SIG.
REF. SIG.
REF. SIG.
REF. SIG.
REF. SIG.
REF. SIG.
REF. SIG.
REF. SIG. 882
REF. SIG. 812
REF. SIG. 884
REF. SIG.
REF. SIG.
REF. SIG.
REF. SIG.
REF. SIG.
REF. SIG.

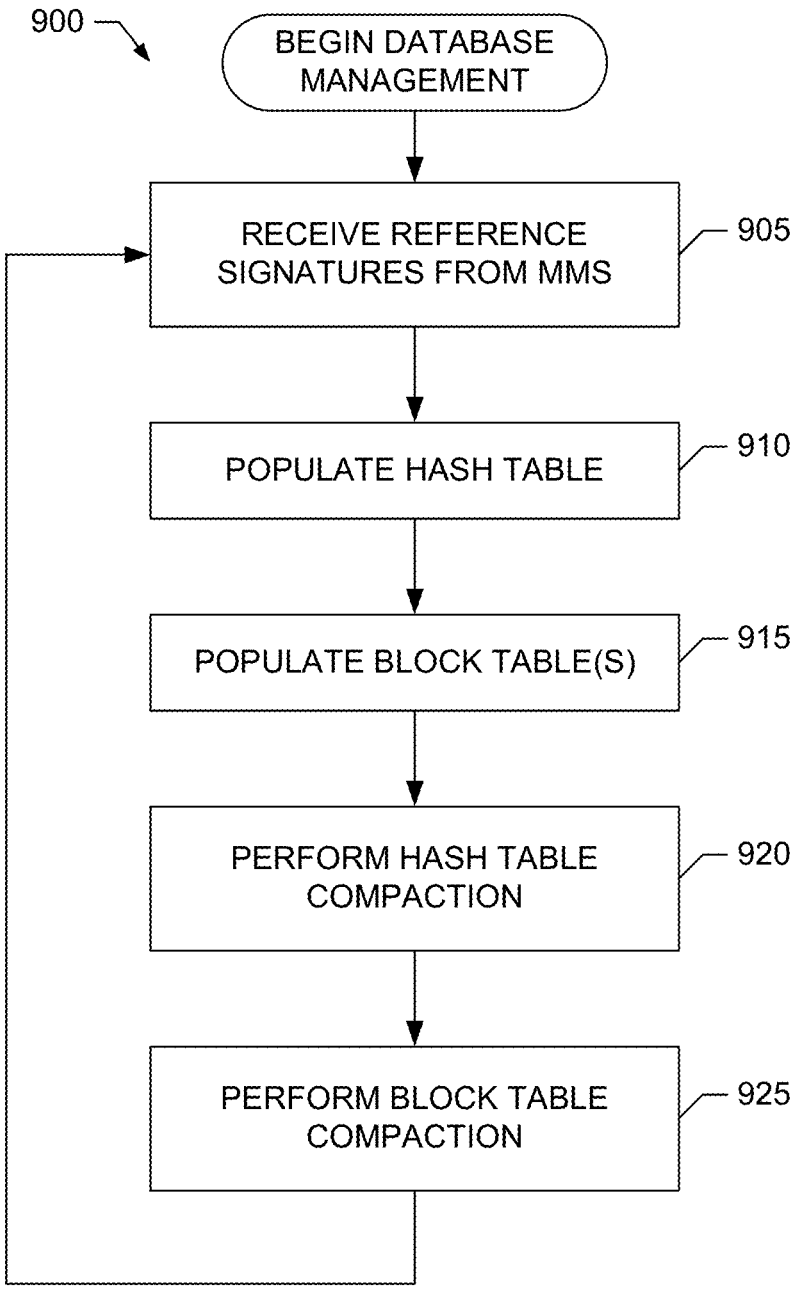

900
BEGIN DATABASE MANAGEMENT
RECEIVE REFERENCE SIGNATURES FROM MMS
905
POPULATE HASH TABLE
910
POPULATE BLOCK TABLE(S)
915
PERFORM HASH TABLE COMPACTION
920
PERFORM BLOCK TABLE COMPACTION
925

FIG. 9

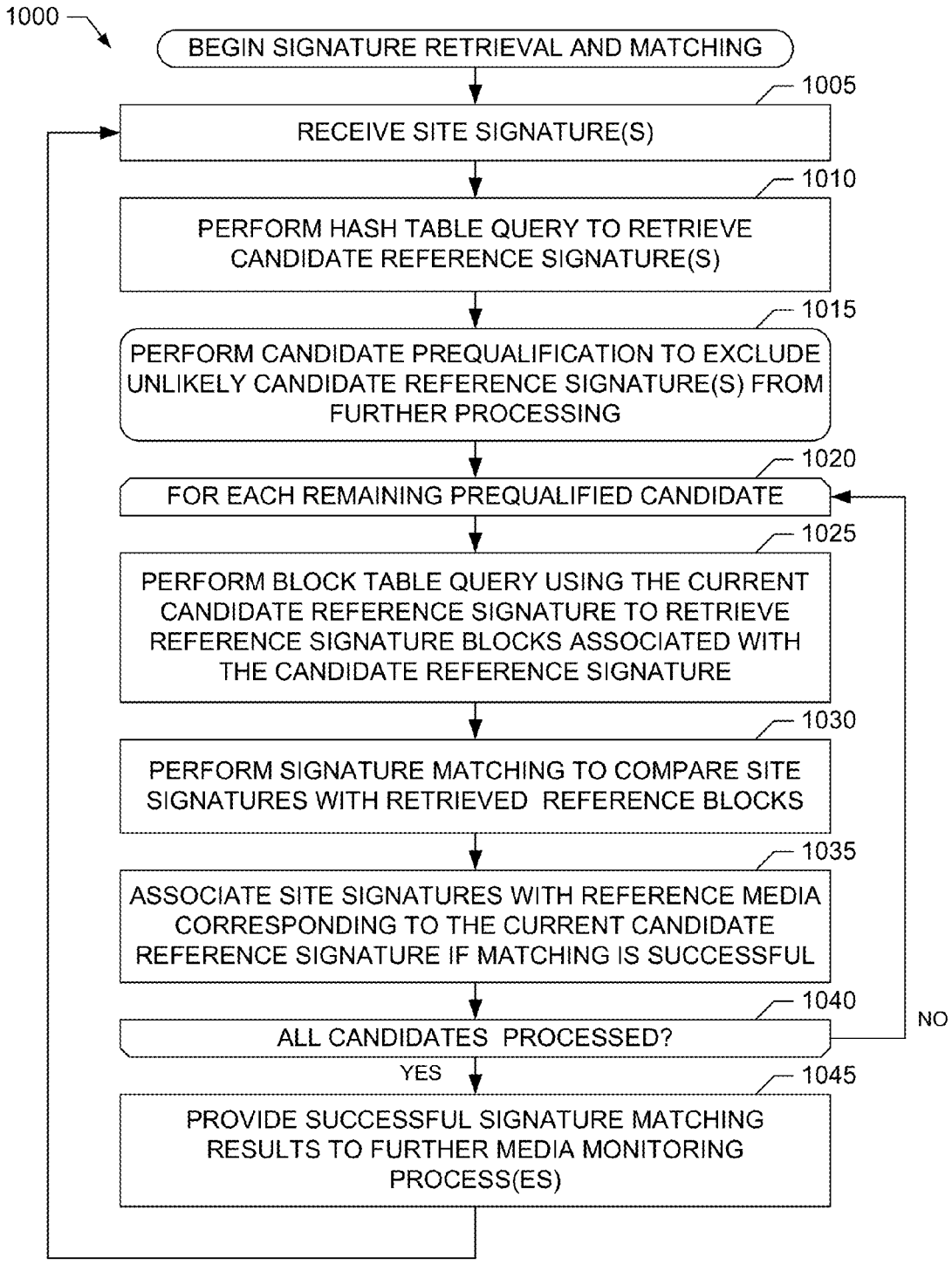

1000
BEGIN SIGNATURE RETRIEVAL AND MATCHING
1005
RECEIVE SITE SIGNATURE(S)
1010
PERFORM HASH TABLE QUERY TO RETRIEVE CANDIDATE REFERENCE SIGNATURE(S)
1015
PERFORM CANDIDATE PREQUALIFICATION TO EXCLUDE UNLIKELY CANDIDATE REFERENCE SIGNATURE(S) FROM FURTHER PROCESSING
1020
FOR EACH REMAINING PREQUALIFIED CANDIDATE
1025
PERFORM BLOCK TABLE QUERY USING THE CURRENT CANDIDATE REFERENCE SIGNATURE TO RETRIEVE REFERENCE SIGNATURE BLOCKS ASSOCIATED WITH THE CANDIDATE REFERENCE SIGNATURE
1030
PERFORM SIGNATURE MATCHING TO COMPARE SITE SIGNATURES WITH RETRIEVED REFERENCE BLOCKS
1035
ASSOCIATE SITE SIGNATURES WITH REFERENCE MEDIA CORRESPONDING TO THE CURRENT CANDIDATE REFERENCE SIGNATURE IF MATCHING IS SUCCESSFUL
1040
ALL CANDIDATES PROCESSED?
NO
YES
1045
PROVIDE SUCCESSFUL SIGNATURE MATCHING RESULTS TO FURTHER MEDIA MONITORING PROCESS(ES)

FIG. 10

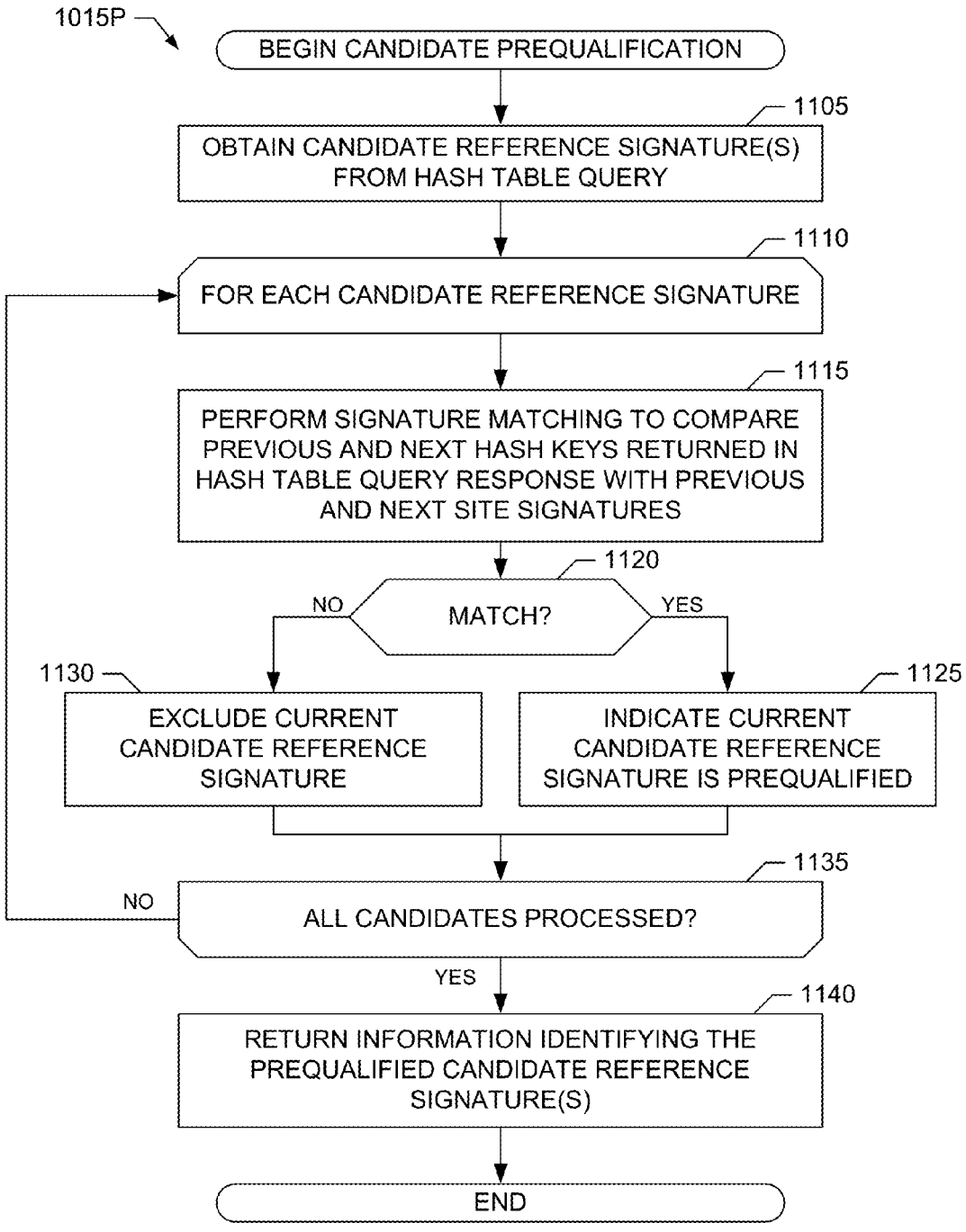

1015P
BEGIN CANDIDATE PREQUALIFICATION
1105
OBTAIN CANDIDATE REFERENCE SIGNATURE(S) FROM HASH TABLE QUERY
1110
FOR EACH CANDIDATE REFERENCE SIGNATURE
1115
PERFORM SIGNATURE MATCHING TO COMPARE PREVIOUS AND NEXT HASH KEYS RETURNED IN HASH TABLE QUERY RESPONSE WITH PREVIOUS AND NEXT SITE SIGNATURES
1120
MATCH?
NO
YES
1130
EXCLUDE CURRENT CANDIDATE REFERENCE SIGNATURE
1125
INDICATE CURRENT CANDIDATE REFERENCE SIGNATURE IS PREQUALIFIED
1135
ALL CANDIDATES PROCESSED?
NO
YES
1140
RETURN INFORMATION IDENTIFYING THE PREQUALIFIED CANDIDATE REFERENCE SIGNATURE(S)
END

FIG. 11

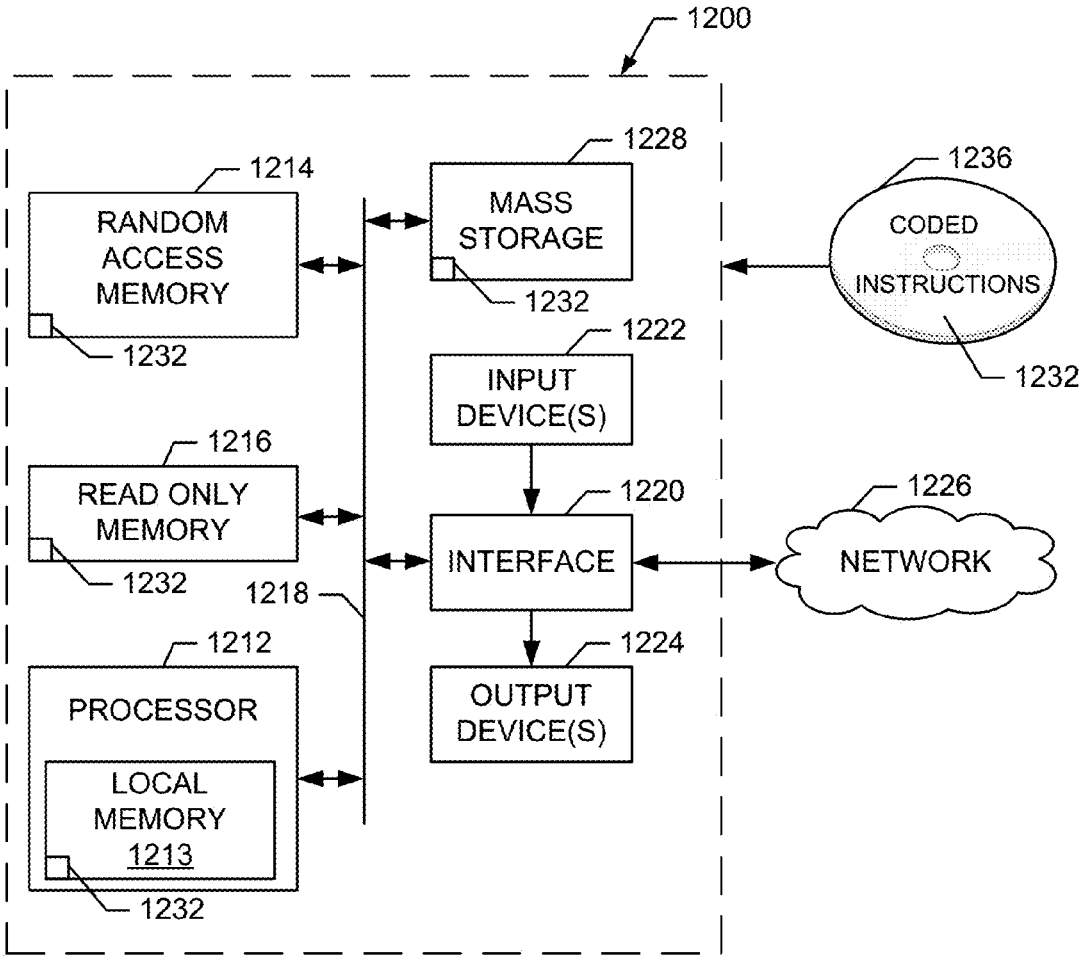

1200
1214
RANDOM ACCESS MEMORY
1232
1228
MASS STORAGE
1232
1236
CODED INSTRUCTIONS
1232
1222
INPUT DEVICE(S)
1216
READ ONLY MEMORY
1232
1220
INTERFACE
1226
NETWORK
1218
1212
PROCESSOR
LOCAL MEMORY 1213
1232
1224
OUTPUT DEVICE(S)

FIG. 12

SIGNATURE RETRIEVAL AND MATCHING FOR MEDIA MONITORING

RELATED APPLICATION(S)

[0001] This patent arises from a continuation of U.S. patent application Ser. No. 14/469,245, filed Aug. 26, 2014, now U.S. patent Ser. No. _____, which claims the benefit of and priority from U.S. Provisional Application Ser. No. 61/976,168, entitled "SIGNATURE RETRIEVAL AND MATCHING FOR MEDIA MONITORING" filed on Apr. 7, 2014. U.S. patent application Ser. No. 14/469,245 and U.S. Provisional Application Ser. No. 61/976,168 are hereby incorporated by reference in their entirety. Priority to U.S. Provisional Application Ser. No. 61/976,168 and U.S. patent application Ser. No. 14/469,245 is hereby claimed.

FIELD OF THE DISCLOSURE

[0002] This disclosure relates generally to media monitoring and, more particularly, to signature retrieval and matching for media monitoring.

BACKGROUND

[0003] A media monitoring system typically includes one or more device meters to monitor the media presented by one or more media devices located at one or more monitored sites. Such a device meter can use watermarks decoded from the presented media and/or signatures (also referred to as media fingerprints or just fingerprints) generated from the presented media, or both, to monitor (e.g., identify and/or track) the media being presented by a media device. For example, identification codes, such as watermarks, ancillary codes, etc., may be transmitted within media signals. Identification codes are data that are transmitted with media (e.g., inserted into the audio, video, or metadata stream of media) to uniquely identify broadcasters and/or the media (e.g., content or advertisements), and/or are associated with the media for another purpose, such as tuning (e.g., packet identifier headers ("PIDs") used for digital broadcasting). Codes are typically extracted using a decoding operation.

[0004] In contrast, signatures are a representation of some characteristic of the media signal (e.g., a characteristic of the frequency spectrum of the signal). Signatures can be thought of as fingerprints. They are typically not dependent upon insertion of identification codes in the media but, instead, preferably reflect an inherent characteristic of the media and/or the signal transporting the media. Systems to utilize codes and/or signatures for audience measurement are long known. See, for example, Thomas, U.S. Pat. No. 5,481,294, which is hereby incorporated by reference in its entirety.

[0005] When signatures are used for media monitoring, signatures of the monitored media (referred to herein as site signatures) are generated by the device meter and compared to reference signatures representative of reference media known to the media monitoring system. When a match is found, the media corresponding to the site signature being processed can be identified as corresponding to the reference media represented by the matching reference signature(s). In many media monitoring systems, the device meters provide their generated site signatures to a data processing facility or other centralized processing site for comparison with the reference signatures that are representative of the reference media available for presentation at the respective monitored sites. Such comparison may involve comparing large numbers of site signatures with large numbers of reference signatures, especially when the number of monitored sites is large and/or the amount of possible reference media available for consumption is large.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. **1** is block diagram of an example system capable of performing signature retrieval and matching for media monitoring as disclosed herein.

[0007] FIG. **2** is a block diagram of an example monitored site that may be included in the example system of FIG. **1**.

[0008] FIG. **3** is a block diagram of an example media monitoring system that may be included in the example system of FIG. **1**.

[0009] FIG. **4** illustrates example site signatures that may be obtained from the example monitored site of FIG. **2**.

[0010] FIG. **5** illustrates example reference signatures that may be obtained from the example media monitoring system of FIG. **3**.

[0011] FIG. **6** is a block diagram of an example crediting facility that may be included in the example system of FIG. **1**.

[0012] FIG. **7** illustrates an example hash table and an example block table that may be used by the example crediting facility of FIG. **6** to perform signature retrieval and matching for media monitoring as disclosed herein.

[0013] FIG. **8** illustrates an example signature matching operation capable of being performed by the example crediting facility of FIG. **6**.

[0014] FIG. **9** is a flowchart representative of first example machine readable instructions that may be executed to implement signature retrieval and matching for media monitoring in the example crediting facility of FIG. **6**.

[0015] FIG. **10** is a flowchart representative of second example machine readable instructions that may be executed to implement signature retrieval and matching for media monitoring in the example crediting facility of FIG. **6**.

[0016] FIG. **11** is a flowchart representative of example machine readable instructions that may be executed to implement candidate prequalification in the example crediting facility of FIG. **6**.

[0017] FIG. **12** is a block diagram of an example processor platform that may execute the example machine readable instructions of FIGS. **9**, **10** and/or **11** to implement the example system of FIG. **1** and/or the example crediting facility of FIG. **6**.

[0018] Wherever possible, the same reference numbers will be used throughout the drawing(s) and accompanying written description to refer to the same or like parts, elements, etc.

DETAILED DESCRIPTION

[0019] Methods, apparatus, systems and articles of manufacture (e.g., physical storage media, structures, etc.) to perform signature retrieval and matching for media monitoring are disclosed herein. Some example signature retrieval and matching methods disclosed herein include querying a first table using a first site signature obtained from a monitored site. For example, the first table can include hash keys corresponding to respective reference signatures, and can further include respective qualifier data descriptive of respective ones of the reference signatures (and/or descriptive of reference media represented by the

respective ones of the reference signatures). Such example methods can also include querying a second table using first qualifier data obtained from querying the first table using the first site signature. For example, the first qualifier data can be descriptive of a first reference signature (and/or first reference media represented by the first reference signature) corresponding to a first hash key determined to match the first site signature. Such example methods can further include comparing a first block of site signatures with a portion of a plurality of blocks of reference signatures obtained from querying the second table using the first qualifier data.

[0020] In some such examples, the first qualifier data includes a first timestamp associated with a first block of reference signatures including the first reference signature. In some such examples, the first qualifier data also includes first media identification data identifying first reference media represented by the first reference signature.

[0021] In some such examples, the plurality of blocks of reference signatures obtained from querying the second table using the first qualifier data include: (1) the first block of reference signatures representative of the first reference media and associated with the first timestamp, (2) a second block of reference signatures representative of the first reference media and associated with a second timestamp preceding the first timestamp, and (3) a third block of reference signatures representative of the first reference media and associated with a third timestamp following the first timestamp. In some such examples, the first qualifier data further includes a first offset specifying a position of the first reference signature in the first block of reference signatures, and the first block of site signatures includes neighboring site signatures of the first site signature. Some such example methods further include aligning the first block of site signatures with a portion of the first, second and third blocks of reference signatures based on the offset. Such example methods can also include comparing the first block of site signatures with the portion of the first, second and third blocks of reference signatures.

[0022] Additionally or alternatively, in some such examples, the first reference signature is representative of first reference media, and the plurality of blocks of reference signatures is a first plurality of blocks of reference signatures representative of the first reference media. Some such example methods further include querying the second table using second qualifier data obtained from querying the first table using the first site signature. For example, the second qualifier data can be descriptive of a second reference signature corresponding to a second hash key determined to match the first site signature, and the second reference signature can be representative of second reference media. Such example methods can also include comparing the first block of site signatures with a portion of a second plurality of blocks of reference signatures obtained from querying the second table using the second qualifier data. For example, the second plurality of blocks of reference signatures can be representative of the second reference media.

[0023] Additionally or alternatively, some such example methods can also include obtaining the first hash key, the first qualifier data and first value data associated with the first hash key in response to querying the first table using a first site signature. Some such example methods can also include using the first value data to prequalify the first hash key as a candidate for subsequent signature processing associated with the first site signature. For example, some such example methods can further include obtaining a second hash key, second qualifier data and second value data associated with the second hash key in response to querying the first table using a first site signature. In such examples, the second hash key can have been determined to match the first site signature, and the second qualifier data can be descriptive of a second reference signature corresponding to the second hash key. Such example methods can also include querying the second table using the second qualifier data in response to a successful prequalification of the second hash key based on the second value data, but not querying the second table using the second qualifier data in response to an unsuccessful prequalification of the second hash key based on the second value data.

[0024] Furthermore, in some such examples, the first reference signature is representative of first reference media, the first value data includes a second hash key and a third hash key both representative of the first reference media, and the second hash key precedes the first hash key in time, whereas the third hash key follows the first hash key in time. In some such examples, using the first value data to prequalify the first hash key includes determining prequalification of the first hash key is successful in response to determining that the second hash key matches a second site signature preceding the first site signature in time and that the third hash key matches a third site signature following the first site signature in time. In some such examples, using the first value data to prequalify the first hash key also includes determining prequalification of the first hash key is unsuccessful in response to determining that at least one of the second hash key fails to match the second site signature or the third hash key fails to match the third site signature.

[0025] These and other example methods, apparatus, systems and articles of manufacture (e.g., physical storage media, structures, etc.) to perform signature retrieval and matching for media monitoring are disclosed in greater detail below.

[0026] As mentioned above, in media monitoring systems employing media signatures, the device meters monitoring media presented by media devices at monitored sites typically provide their generated site signatures to a data processing facility or other centralized processing site for comparison with the reference signatures that are representative of the possible reference media available for presentation at the respective monitored sites. In prior media monitoring systems, the central data processing facility may store the reference signatures in random access memory (RAM) for comparison with the site signatures obtained from the monitored sites. However, as the amount of possible reference media available for presentation increases, the number of possible reference signatures to be compared also increases. In prior media monitoring systems, the increasing number of references signatures requires more and more RAM to store the reference signatures for comparison, to the point at which the amount of RAM may become cost prohibitive and/or unwieldy to manage.

[0027] In contrast, media monitoring systems employing signature retrieval and matching as disclosed herein can perform signature matching more efficiently than prior systems. Some example media monitoring systems employing signature retrieval and matching as disclosed herein utilize a database employing a double index hashing strategy in which a first table—a hash table—is stored in RAM and

queried using site signatures obtained from monitored sites to retrieve candidate reference signatures for further examination. The first hash table can be relatively lightweight and have a smaller RAM footprint than that of prior media monitoring systems. The double index hashing strategy of such examples also utilizes a second table—a block table—storing blocks of reference signatures that can be retrieved for matching using the candidate reference signatures retrieved from the hash table. The block table need not be stored in RAM (although it could be), and may or may not be stored remotely from the hash table. The (relatively few) blocks of signatures retrieved from the block table can be temporarily stored in RAM for signature matching. In some examples, signature matching processing is offloaded to servers or other computing devices implementing the block table, thereby supporting parallel and/or distributed data processing.

[0028] Turning to the figures, a block diagram of an example system **100** capable of performing signature retrieval and matching for media monitoring as disclosed herein is illustrated in FIG. **1**. The example system **100** of FIG. **1** includes one or more example media distributor(s) **105** to distribute media for presentation by media devices. A media distributor **105** can correspond to any type of media distributor, such as a television station, a cable network, a satellite network (e.g., television or radio), a radio station, a streaming media service (e.g., such as Hulu™, Netflix®, etc.), etc. As such, the media distributed by the media distributor(s) **105** can correspond to any type of media, such as television programming, radio programming, multimedia (e.g., audio and/or visual) data, etc. In the illustrated example, the media distributor(s) **105** can distribute a particular piece of media (e.g., such as a particular television program, a particular radio program, a particular movie, etc.) to recipients (e.g., television viewers, radio listeners, computer users, electronic device users, etc.) via one or more example distribution media **110** (e.g., such a one or more radio frequency, cable and/or satellite television and/or radio channels, one or more networks carrying one or more digital transport channels, etc.).

[0029] In the example system **100** of FIG. **1**, the media distributor(s) **105** distribute media via the distribution media **110** to one or more example monitored sites **120** that, for example, correspond to one or more panelists selected (e.g., statistically) for inclusion in an audience measurement panel, media monitoring survey, etc. Each monitored site **120** includes one or more media devices to present the media received at the monitored site. Each monitored site **120** also includes one or more device meters to monitor the media presented by these media device(s). For example, a device meter at a particular monitored site **120** can determine metering data that may identify and/or be used to identify media presented by a media device (and, thus, infer media exposure) at the monitored site **120**. In some examples, the monitored site **120** also includes a people meter to determine audience identification data (also referred to as demographic data, people meter data, etc.) identifying the audience members (e.g., panelists) being exposed to the monitored media, and/or in the vicinity of the monitored media device, etc. In such examples, the device meter combines the metering data with the audience identification data to determine audience measurement data characterizing media exposure at the monitored site **120**. The device meter can then store and report the metering data (or audience measurement data) to an example crediting facility **115** via an example reporting medium **125**. In the illustrated example, the reporting medium **125** can be any type of data transmission medium, such as one or more data networks (e.g., such as the Internet), one or more mobile telephone (e.g., cellular) networks, a dial-up connection, etc. An example implementation of a monitored site **120** is illustrated in FIG. **2**, which is described in greater detail below.

[0030] In the system **100** of the illustrated example, the crediting facility **115** performs signature retrieval and matching for media monitoring as disclosed herein. Unlike media monitoring techniques based on codes and/or watermarks included with and/or embedded in the monitored media, signature-based media monitoring techniques generally use one or more inherent characteristics of the monitored media during a signature sampling interval to generate a substantially unique proxy for the media. Such a proxy is referred to as a signature or media fingerprint, and can take the form of a series of bits, data values, a waveform, etc., representative of the media signal(s) (e.g., an audio signal and/or a video signal) forming the media presentation being monitored. A good signature is usually one that is repeatable when processing the same media presentation, but that is unique relative to other (different) presentations of other (different) media. Thus, as used herein, a signature is a representation of some characteristic of the media signal (e.g., a characteristic of the frequency spectrum of the signal) which can be used to identify the signal, and can be thought of as a fingerprint. Signatures are typically not dependent upon insertion of identification codes in the media, but instead preferably reflect an inherent characteristic of the media and/or the signal transporting the media. Systems to utilize codes and/or signatures for audience measurement are long known. See, for example, Thomas, U.S. Pat. No. 5,481,294, which is hereby incorporated by reference in its entirety.

[0031] In the example system **100** of FIG. **1**, signature-based media monitoring generally involves a device meter determining (e.g., generating) site signature(s) (also referred to as collected signature(s) or metered signature(s)) representative of a media signal (e.g., an audio signal and/or a video signal) output by a monitored media device at a monitored site **120**. The device meter at the monitoring site **120** includes the site signature(s) in the metering data reported to the example crediting facility **115**. The crediting facility **115** then compares the site signature(s) to one or more references signatures corresponding to known (e.g., reference) media. Various comparison criteria, such as a cross-correlation value, a Hamming distance, population (POP) count, etc., can be evaluated to determine whether a site signature (or block of site signatures) matches a particular reference signature (or block of reference signatures). When a match between the site signature(s) and one of (or a block of) the reference signatures is found, the monitored media represented by the site signature(s) can be identified as corresponding to the particular reference media represented by the reference signature(s) that matched the site signature(s). Because attributes, such as an identifier of the media, a presentation time, a broadcast channel, etc., are collected and, thus, known for the reference media represented by the matching reference signature(s), the crediting facility **115** may associate the monitored media with these same attributes of the matching reference media. The crediting facility **115** can then use the identified attributes of the

monitored media to perform any appropriate post-processing to, for example, determine audience ratings information, identify targeted advertising to be provided to the monitored site **120**, etc.

[0032] The crediting facility **115** of the illustrated example employs signature retrieval and matching as disclosed herein to facilitate efficient retrieval of reference signatures for comparison with the site signatures obtained from the monitored sites **120**. As disclosed in further detail below, the example crediting facility **115** utilizes a database employing a double index hashing strategy involving a first table, referred to herein as a hash table, and a second table, referred to herein as a block table. The hash table is arranged such that each entry corresponds to a reference signature and is indexed using a hash key, which may correspond to a hash of the reference signature or the data value of the reference signature itself. The hash table entry for a particular reference signature also includes qualifier data descriptive of the reference signature and, in at least some examples, value data that may be used to prequalify the reference signature as a good candidate for further signature matching processing, as described in further detail below. The block table is arranged such that each entry corresponds to a particular value, or combination of values, of the qualifier data and, thus, is indexed using qualifier data retrieved in response to querying the hash table. The block table entry for a particular value, or combination of values, of the qualifier data also includes blocks of reference signatures corresponding to that qualifier data, which can be retrieved for comparison with a block of site signature(s) reported by the device meter at a monitored site **120**. Operation of the crediting facility **115** to use the hash table and block table for signature retrieval and matching is described in further detail below in connection with the example implementation of the crediting facility **115** illustrated in FIG. **6**.

[0033] The example system **100** of FIG. **1** also includes an example media monitoring system (MMS) **130** to generate some or all of the reference signatures used by the crediting facility **115**. As described in further detail below, in some examples, the MMS **130** is located separately from the monitored site(s) **120** and monitors media distributions by some or all of the media distributor(s) **105**. The MMS **130** determines reference signatures from the media distributions, which correspond to the possible media that could be received by the monitored site(s) **120**. For example, for each media distribution monitored by the MMS **130**, the MMS **130** generates respective reference signatures (e.g., blocks of reference signatures associated with a signature monitoring interval), timestamps the reference signatures with time information (e.g., such as day and/or time-of-day information) corresponding to when the monitored media was received at the MMS **130**, and associates media identification information with the reference signatures. The MMS **130** then stores and reports the timestamped reference signatures and media identification information to the crediting facility **115** via an example reporting medium **135**. In the illustrated example, the reporting medium **135** can be any type of data transmission medium, such as one or more data networks (e.g., such as the Internet), one or more mobile telephone (e.g., cellular) networks, a dial-up connection, etc. An example implementation of the MMS **130** is illustrated in FIG. **3**, which is described in greater detail below.

[0034] A block diagram of an example implementation of one of the monitored sites **120** of FIG. **1** is illustrated in FIG. **2**. The example monitored site **120** of FIG. **2** includes an example media presentation device **205** (also referred to herein as a media device **205**) to present media received via the distribution medium **110**. The media presentation device **205** can correspond to any type of media device, such as a set-top box, a television, a radio, a multimedia computer system, tablet computer, a portable digital assistant, a cellular/mobile smartphone, etc.

[0035] The example monitored site **120** of FIG. **2** also includes an example device meter **210**, also referred to as a meter **210**, a site meter **210**, a site unit **210**, a home unit **210**, a media meter **210**, etc., to monitor media presented by the media device **205**. In the illustrated example, the media monitored by the device meter **210** can correspond to any type of media presentable by the media device **205**. For example, monitored media can be media content, such a television programs, radio programs, movies, etc., and/or commercials, advertisements, etc. In the illustrated example, the device meter **210** determines metering data that may identify and/or be used to identify media exposure (and, thus, infer media consumption) at the monitored site **120**. The metering data determined by the example device meter **210** includes site signatures representative of the media presented by the media device **205**.

[0036] For example, in the example monitored site **120** of FIG. **2**, the device meter **210** may utilize invasive monitoring involving one or more physical connections to the media device **205**, and/or non-invasive monitoring not involving any physical connection to the media device **205**, to obtain access to one or more media signals corresponding to the media being presented by the media device **205**. In some examples, the device meter **210** may process audio signals obtained from the media device **205** via a microphone and/or other audio sensor(s), and/or via a direct cable connection, to generate audio site signatures representative of the media being presented by the media device **205**. Additionally or alternatively, the device meter **210** may process video signals obtained from the media device **205** via a camera and/or other video sensor(s), and/or a direct cable connection, to generate video site signatures (e.g., image signatures) representative of the media being presented by the media device **205**. The site signatures generated by the device meter **210** at respective generation intervals can then be compared (e.g., at the crediting facility **115**) with known reference signatures to identify/monitor the media being presented by the media device **205**.

[0037] In some examples, the monitored site **120** also includes an example people meter **215** to capture audience identification information describing an audience being exposed to the media presented by the media device **205**. In some examples, the people meter **215** can prompt audience member(s) in the vicinity of the media device **205** to identify which one or more of a possible group of audience members are present in the audience. Additionally or alternatively, in some examples, the people meter **215** can automatically identify one or more individual included in an audience in the vicinity of the media device **205**. In such examples, the device meter **210** may combine the metering data identifying (e.g., directly or indirectly) the media being presented by the media device **205** with the audience identification data determined by the people meter **215** to form audience

measurement data characterizing media exposure (e.g., with demographic information) at the monitored site **120**.

[0038] The device meter **210** of the illustrated example stores the metering data (or audience measurement data), including the generated site signatures, for reporting to the crediting facility **115** via the reporting medium **125**. The generated site signatures in the metering data are also timestamped to allow the site signatures to be associated with the particular time when the site signatures were generated. The timestamps also indicate the time at which the monitored media represented by the site signatures was presented at the monitored site **120**. The device meter **210** can report the metering data/audience measurement data (including the site signatures and timestamps) as it is collected (e.g., streamed), at specified/predetermined time intervals, when a certain amount of data has been collected, when an available memory space is filled or reaches a threshold capacity (e.g., 90% or some other percentage being full), and/or via any other periodic, aperiodic and/or event-driven schedule.

[0039] Example site signatures that can be generated and reported by the example device meter **210** of FIG. **2** are illustrated in FIG. **4**. In the illustrated example of FIG. **4**, the device meter **210** generates example site signatures **405**A-C at successive signature generation intervals. The example site signatures **405**A-C, collectively referred to as the site signatures **405**, are digital values represented by some number of bits. For example, each site signature **405**A-C may be a digital value represented by 3 bytes, which corresponds to 24 bits. Of course, the site signatures **405**A-C may be digital values represented by a different number of bits. As described above, the digital values making up the site signatures **405**A-C may correspond to, for example, spectral-domain values, time-domain values and/or values of other characteristics of the media signal(s) presented by the media device **205** monitored by the device meter **210**.

[0040] In the illustrated example of FIG. **4**, the device meter **210** associates the site signatures **405**A-C with respective example timestamps **410**A-C, collectively referred to as the timestamps **410**, as well as other metering metadata, such as a meter identifier, one or more panelist identifiers, etc. The example timestamp **410**A can be a day/time value indicating the time at which the respective site signature **405**A was generated. For example, the device meter **210** may be configured to generate site signatures at a particular signature generation interval (e.g., approximately a 15 millisecond (ms) interval, corresponding to generating 64 signatures per second, or at some other interval). In such examples, the timestamps **410**A-C can have sufficient resolution to identify the particular signature generation interval at which a particular one of the site signatures **405**A-C was generated. Although each site signature **405**A-C is associated with a respective timestamp **410**A-C in the example of FIG. **4**, in other examples, multiple site signatures (e.g., a block of site signatures) may be associated with a single timestamp (e.g., which identifies the starting time at which the block of site signatures was generated).

[0041] A block diagram of an example implementation of the MMS **130** of FIG. **1** is illustrated in FIG. **3**. As discussed above, the MMS **130** may be located separately from the monitored site(s) **120** and monitors one, some or all of the different media being distributed by the media distributor(s) **105** via the distribution media **110**. In the illustrated example of FIG. **3**, the MMS **130** includes one or more media receivers **305** to receive media being distributed by the media distributor(s) **105** via the distribution media **110**. For example, the media receiver(s) **305** can include multiple receivers assigned to respective media distributors **105**, such as particular television channels/networks, particular radio channels/networks, particular streaming services, etc. Additionally or alternatively, one or more of the media receiver(s) **305** can be shared (e.g., time-multiplexed) among multiple media distributors **105**.

[0042] The example MMS **130** of FIG. **3** also includes one or more signature generators **310** to generate reference signatures representative of the media received by the media receiver(s) **305**. For example, the signature generator(s) **310** can include audio signature generator(s) to generate audio signatures representative of the audio signal(s) corresponding to audio portion(s) of the media received by the media receiver(s) **305**. Additionally or alternatively, the signature generator(s) **310** can include video signature generator(s) to generate video (e.g., image) signatures representative of the video signal(s) corresponding to video portion(s) of the media received by the media receiver(s) **305**. As such, in some examples, the signature generator(s) **310** may implement signature generation technique(s) similar to those implemented by the device meter(s) **210** at the monitored sites(s) **120**.

[0043] The signatures generated by the signature generator(s) **310** are reference signatures that can be used (e.g., by the crediting facility **115**) to identify corresponding media being distributed by the media distributor(s) **105**. For example, for each media distribution received and processed by the MMS **130**, the reference signatures output from the signature generator(s) are associated with media identification data (e.g., such as a source identifier, a stream identifier, etc., as described in further detail) identifying the particular media represented by the reference signatures. Such media identification data can be known to the MMS **130** based on, for example, the known association of the media receiver(s) **305** to the respective media distributor(s) **105**.

[0044] The example MMS **130** of FIG. **3** further includes one or more time determiner(s) **315** to determine time information for association with the reference signatures determined by the signature generator(s) **310**. For example, a signature generator **310** can trigger a time determiner **315** to determine time information (e.g., timestamps) indicating when reference signatures for a particular piece of media were generated and, thus, when the corresponding reference media was received by the respective media receiver **305**. The time information can include, for example, the particular day and/or time-of-day at which a particular block of reference signatures was generated, which corresponds to the particular day and/or time-of-day at which the media represented by this block of reference signatures was received by the MMS **130**. In some examples, each signature generator **310** is associated with a respective time determiner **315**. In some examples, groups of signature generators **310** are associated with a respective time determiner **315**. The time determiner(s) **315** can include any timing source, such as a clock, timer, etc., capable of providing time information having an acceptable accuracy.

[0045] Example reference signatures that can be generated and reported by the example MMS **130** of FIG. **3** are illustrated in FIG. **5**. In the illustrated example of FIG. **5**, the MMS **130** generates example reference signature blocks **505**, which contain one or more example reference signa-

tures, at successive signature generation intervals. Each of the reference signatures included in an example reference signature block **505** is a digital value represented by some number of bits. For example, each reference signature in the reference signature block **505** may be a digital value represented by 3 bytes, which corresponds to 24 bits. Of course, the reference signatures in the reference signature block **505** may be digital values represented by a different number of bits. As described above, the digital values making up the reference signatures in the reference signature block **505** may correspond to, for example, spectral-domain values, time-domain values and/or one or more values of one or more other characteristics of the media signal(s) received by the media receiver(s) **305** at the MMS **130**.

[0046] In the illustrated example of FIG. **5**, the MMS **130** associates the reference signature block **505** with other reference metadata, such as a respective example timestamp **510** and a respective example media identifier **515**. The example timestamp **510** can be a day/time value indicating the start time at which the reference signature block **505** was generated. For example, a signature generator **310** at the MMS **130** may be configured to generate reference signatures at a particular signature generation interval (e.g., approximately a 15 ms interval, corresponding to generating 64 signatures per second, or some other interval). In such examples, the timestamp **510** can have sufficient resolution to identify the start time at which the reference signatures included in the reference signature block **505** were generated. For example, in the case of the signature generator **310** being configured to generate 64 reference signatures per second (e.g., corresponding to a signature generation interval of approximately 15 ms), then the timestamp **510** may have a resolution of 1 second (sec.) if the reference signature block **505** contains 64 reference signatures, 2 sec. if the reference signature block **505** contains 128 reference signatures, etc. In the illustrated example of FIG. **5**, the media identifier **515** may include a source identifier, a stream identifier, etc., identifying the particular reference media represented by the reference signatures in the reference signature block **505**.

[0047] Returning to FIG. **3**, the illustrated example MMS **130** also includes an example data reporter **320** to report reference data to the crediting facility **115** via the example reporting medium **135**. For example, the reference data reported by the example data reporter **320** can include reference signature blocks **505** and associated timestamps **510** and media identifiers **515** generated by the signature generator(s) **310** and the time determiner(s) **315**. The data reporter **320** can report the reference data (including the reference signature blocks **505**, the associated timestamps **510** and the media identifiers **515**) as it is collected (e.g., streamed), at specified/predetermined time intervals, when a certain amount of data has been collected, when an available memory space is filled or reaches a threshold capacity (e.g., 90% or some other percentage being full), etc.

[0048] A block diagram of an example implementation of the crediting facility **115** of FIG. **1** is illustrated in FIG. **6**. The block diagram of FIG. **6** illustrates structures associated with implementing signature retrieval and matching at the crediting facility **115**. Other structures implemented by the crediting facility **115** have been omitted for clarity.

[0049] Turning to FIG. **6**, the illustrated example crediting facility **115** includes an example MMS interface **605** to interface with an MMS, such as the example MMS **130** of FIGS. **1** and/or **3**. As such, the MMS interface **605** can be implemented using any interface technology, communication device(s), etc., capable of interfacing with and receiving data via the example reporting medium **135**. The example MMS interface **605** receives reference data from the MMS **130** including, for example, the reference signature blocks **505**, the associated timestamps **510** and the media identifiers **515**.

[0050] As mentioned above, the crediting facility **115** of the illustrated example employs a double index hashing strategy for signature retrieval and matching, which involves a first table, referred to herein as a hash table, and a second table, referred to herein as a block table. Accordingly, the example crediting facility **115** of FIG. **6** includes an example hash table populator **610** to populate a hash table to be used by the crediting facility **115**. The example crediting facility **115** of FIG. **6** also includes an example block table populator **615** to populate a block table to be used by the crediting facility **115**. An example hash table **710** and an example block table **715** that can be used by the crediting facility **115** for signature retrieval and matching are illustrated in FIG. **7**.

[0051] Turning to FIG. **7**, the example hash table **710** illustrated therein includes entries (e.g., rows) corresponding to the respective reference signatures received from the MMS **130** via the MMS interface **605**. For example, each entry of the hash table **710** corresponds to a respective reference signature and is indexed using an example hash key **712**. The hash key **712** may correspond to a value of the particular reference signature corresponding to the hash table entry, or may correspond to a hash of the reference signature value (e.g., to reduce data space). For convenience, in the following description, the hash key **712** is assumed to correspond to the value of the particular reference signature corresponding to the hash table entry.

[0052] In the illustrated example, the entry of the hash table **710** corresponding to a particular reference signature represented by the hash key **712** also includes example qualifier data **720** descriptive of the reference signature. For example, the qualifier data **720** can include metadata, such as an example timestamp **722**, an example source identifier **724**, an example stream identifier **726** and an example offset **728**. In the illustrated example of FIG. **7**, the timestamp **722** included in the qualifier data **720** corresponds to the timestamp **510** of the particular reference signature block **505** reported by the MMS **130** and containing the particular reference signature corresponding to the hash table entry. In the illustrated example of FIG. **7**, the source identifier **724** and the stream identifier **726** are obtained from the media identifier **515** reported by the MMS **130** for the particular reference signature block **505** containing the particular reference signature corresponding to the hash table entry. In the illustrated example of FIG. **7**, the offset **728** identifies the position of the particular reference signature, which corresponds to the hash table entry, in its respective reference signature block **505** reported by the MMS **130**. As such, in the illustrated example of FIG. **7**, the timestamp **722**, source identifier **724**, and stream identifier **726** will be the same for the hash table entries corresponding to reference signatures included in the same reference signature block **505**. However, the offset **728** will be different for each of these hash table entries and will provide the particular position of each reference signature in the reference signature block **505**.

[0053] In some examples, the entry of the hash table **710** corresponding to a particular reference signature represented

by the hash key **712** further includes example value data **730** that may be used to prequalify the reference signature corresponding to the hash table entry as a good candidate for further signature matching processing. In the illustrated example of FIG. **7**, the value data **730** includes an example previous hash key **732** and an example next hash key **734**. The previous hash key **732** corresponds to a reference signature preceding the particular reference signature corresponding to the hash key **712** and having the same source identifier **724** and stream identifier **726**. Referring to the particular reference signature corresponding to the hash key **712** as the current reference signature, then the previous hash key **732** may correspond to a reference signature preceding the current signature in the same reference signature block **505**, or in the preceding reference signature block **505** for the same source identifier **724** and stream identifier **726**. In some examples, the previous hash key **732** corresponds to the reference signature immediately preceding the current reference signature, whereas in other examples, there may be one or more intervening reference signatures between the current reference signature and the preceding reference signature corresponding to the previous hash key **732**. The next hash key **734** corresponds to a reference signature following the particular reference signature corresponding to the hash key **712** and having the same source identifier **724** and stream identifier **726**. Again referring to the particular reference signature corresponding to the hash key **712** as the current reference signature, then the next hash key may correspond to a reference signature following the current signature in the same reference signature block **505**, or in the following reference signature block **505** for the same source identifier **724** and stream identifier **726**. In some examples, the next hash key **734** corresponds to the reference signature immediately following the current reference signature, whereas in other examples, there may be one or more intervening reference signatures between the current reference signature and the subsequent reference signature corresponding to the previous hash key **732**. Similar to the hash key **712**, the previous hash key **732** and next hash key **734** may be equal to the values of their respective reference signatures, or may correspond to a hash of the respective reference signature values (e.g., to reduce data space). For convenience, in the following description, the previous hash key **732** and next hash key **734** are assumed to correspond to the values of the respective previous and next reference signatures. Use of the previous hash key **732** and next hash key **734** to prequalify the reference signature corresponding to the current hash key **712** is described in further detail below.

[0054] The example block table **715** illustrated in FIG. **7** includes entries corresponding to each reference signature block **505** reported by the MMS **130**. In the example of FIG. **5**, each reference block **505** is identifiable using its respective timestamp **510** and media identifier **515**. Accordingly, each entry of the block table **715** is indexed using an example key **750** including metadata, such as an example timestamp **752**, an example source identifier **754** and an example stream identifier **756**. In the illustrated example of FIG. **7**, the timestamp **752**, the source identifier **754** and the stream identifier **756** correspond respectively to the timestamp **722**, the source identifier **724** and the stream identifier **726** included in the example qualifier data **720** of the example hash table **710**. As such, the qualifier data **720** returned in response to querying the hash table **710** can be used to index into the example block table **715**. In the illustrated example of FIG. **7**, the timestamp **752** included in the key **750** corresponds to the timestamp **510** of the particular reference signature block **505** corresponding to the block table entry. In the illustrated example of FIG. **7**, the source identifier **754** and the stream identifier **756** of the key **750** are obtained from the media identifier **515** reported by the MMS **130** for the particular reference signature block **505** corresponding to the block table entry.

[0055] The entry of the block table **715** corresponding to a particular reference signature block represented by the key **750** also includes example value data **760**, which includes the current reference signature block **762** corresponding to this entry of the block table **715**, as well as the previous reference signature block **764** and the next reference signature block **766**. In the illustrated example of FIG. **7**, the previous reference signature block **764** corresponds to the reference signature block **505** preceding the current reference signature block **762** in time and that is associated with the same source identifier **754** and stream identifier **756** as the current reference signature block **762**. As such, the timestamp **510** of the previous reference signature block **764** may be the immediately preceding timestamp relative to the timestamp **752**. In the illustrated example of FIG. **7**, the next reference signature block **766** corresponds to the reference signature block **505** following the current reference signature block **762** in time and that is associated with the same source identifier **754** and stream identifier **756** as the current reference signature block **762**. As such, the timestamp **510** of the next reference signature block **766** may be the immediately following timestamp relative to the timestamp **752**.

[0056] In some examples, the entry of the block table **715** corresponding to a particular reference signature block represented by the key **750** further includes example qualifier data **770**. In the illustrated example of FIG. **7**, the qualifier data **770** includes example version data **772**, which may be used to specify particular characteristics of the data stored in the block table **715**. For example, FIG. **7** depicts specific example data sizes for the different data values in the entries of the hash table **710** and the block table **715**. These data sizes may be associated with a particular value of the version data **772**. In such examples, different values of the version data **772** may be used to specify different data sizes, or combinations of sizes, for the different data values in the entries of the block table **715**.

[0057] In some examples, the hash table **710** and/or the block table **715** are implemented by one or more databases. For example, the hash table **710** and the block table **715** may be implemented by the crediting facility **115** using an Apache HBase™ database solution, a Structured Query Language (SQL) database solution, etc.

[0058] Returning to FIG. **6**, the example hash table populator **610** of the illustrated example receives the reference signature blocks **505** and associated timestamps **510** and media identifiers **515** from the MMS **130** via the MMS interface **605**. The hash table populator **610** of the illustrated example then populates the hash table **710**, which is stored in an example hash table storage **620**, using the received reference signature blocks **505** and associated timestamps **510** and media identifiers **515**. For example, for a particular received reference signature block **505**, the hash table populator **610** populates each reference signature included in the block **505** as a respective hash key **712** corresponding to a

respective entry of the hash table **710**. The hash table populator **610** of the illustrated example also populates the timestamp **722** for this hash table entry with the value of the timestamp **510** associated with the reference signature block **505**, and populates the source identifier **724** and the stream identifier **726** for this hash table entry based on the media identifier **515** associated with the reference signature block **505**. The hash table populator **610** further populates the offset **728** for this hash table entry with the position, in the reference block **505**, of the particular reference signature corresponding to the hash key **712**. In some examples, the hash table populator **610** populates the previous hash key **732** and the next hash key **734** of the value data **730** with the appropriate previous and next reference signatures relative to the particular reference signature corresponding to the hash key **712**.

[0059] In some examples, the example hash table storage **620** is implemented by RAM to enable relatively fast access and processing of the hash table **710**. For example, the hash table storage **620** can be implemented by the volatile memory **1214** and/or the local memory **1213** of the example processor platform **1200** of FIG. **12**. In other examples, the hash table storage **620** is implemented by any mass storage device, such as one or more of the example mass storage devices **1228** of the example processor platform **1200** of FIG. **12**. The example processor platform **1200** of FIG. **12** is described in further detail below.

[0060] The example block table populator **615** receives the reference signature blocks **505** and associated timestamps **510** and media identifiers **515** from the MMS **130** via the MMS interface **605**. The block table populator **615** of the illustrated example then populates the block table **715**, which is stored in an example block table storage **625**, using the received reference signature blocks **505** and associated timestamps **510** and media identifiers **515**. For example, for a particular received reference signature block **505**, the block table populator **615** populates the key **750** of an entry in the block table **715** corresponding to the received reference signature block **505** as follows. The block table populator **615** populates the timestamp **752** of the key **750** for this block table entry with the value of the timestamp **510** associated with the reference signature block **505**, and populates the source identifier **754** and the stream identifier **756** of the key **750** for this block table entry based on the media identifier **515** associated with the reference signature block **505**. The block table populator **615** further populates the current reference signature block **762** of the value data **760** for this block table entry with the reference signatures included in the received reference signature block **505**. Additionally, the block table populator **615** populates the previous reference signature block **764** and the next reference signature block **766** with the appropriate previous and next reference signature blocks relative to the current reference signature block **762**. In some examples, the block table populator **615** also populates the qualifier data **770** for this block table entry with the appropriate version data **772**.

[0061] The example block table storage **625** may be implemented by any appropriate memory, storage device, etc., such as one or more of the volatile memory **1214**, the local memory **1213**, the mass storage device **1228** of the example processor platform **1200** of FIG. **12**. The example processor platform **1200** of FIG. **12** is described in further detail below. Also, in some examples, the block table storage **625** may correspond to multiple storages **625** storing multiple block tables **715** (e.g., remotely).

[0062] The example crediting facility **115** of FIG. **6** also includes an example site interface **630** to interface with a monitored site, such as the example monitored site **120** of FIGS. **1** and/or **2**. As such, the site interface **630** can be implemented using any interface technology, communication device(s), etc., capable of interfacing with and receiving data via the example reporting medium **125**. The example site interface **630** receives metering data from the monitored site **120** including, for example, the site signatures **405** and the associated timestamps **410**.

[0063] The example crediting facility **115** of FIG. **6** further includes an example hash table query processor **635** to query the hash table **710** stored in the hash table storage **620** using the site signatures **405** received via the site interface **630**. For example, the hash table query processor **635** can implement an appropriate database query (e.g., such as an HBase query) to query the hash table **710** using a first site signature, such as the site signature **405**A. In response to the query, the hash table query processor **635** returns one or more hash table entries corresponding respectively to one or more hash keys **712** (e.g., reference signatures) determined to match the site signature **405**A. For example, for a particular hash key **712** (e.g., reference signature) determined to match the site signature **405**A, the hash table query processor **635** of the illustrated example returns the qualifier data **720** (e.g., the timestamp **722**, the source identifier **724**, the stream identifier **726** and the offset **728**) and the value data **730** (e.g., the previous hash key **732** and the next hash key **734**) stored in the hash table entry corresponding to the matching hash key **712**.

[0064] Because multiple hash keys **712** (e.g., reference signatures) may match a particular site signature (e.g., the site signature **405**A), the example crediting facility **115** of FIG. **6** includes an example candidate qualifier **640** to prequalify candidate hash keys **712**, which have been determined to match a particular site signature, for use in subsequent matching processing. For example, the hash table query processor **635** may return multiple hash keys **712** (and their associated hash table entries) in response to querying the hash table **710**. These hash keys **712** are referred to herein as candidate hash keys **712** because one or more of these keys may not actually correspond to the media represented by the site signature used to query the hash table **710** (e.g., due to false matches). In such an example, the candidate qualifier **640** examines the candidate hash keys **712** to determine which ones should be retained as prequalified hash keys **712** that can form the basis for subsequent queries of the block table **715**.

[0065] In the illustrated example, the candidate qualifier **640** performs prequalification of a particular candidate hash key **712** using the value data **730** associated with the candidate hash key **712**. For example, the candidate qualifier **640** of the illustrated example can obtain the previous hash key **732** and the next hash key **734** included in the value data **730** for the particular candidate hash key **712**. As noted above, the previous hash key **732** corresponds to the hash key (e.g., reference signature) preceding the hash key **712** in time, and the next hash key **734** corresponds to the hash key (e.g., reference signature) following the hash key **712** in time. In such examples, the candidate qualifier **640** compares the previous hash key **732** with the neighboring site signature preceding, in time, the site signature used to query

the hash table **710**, and compares the next hash key **734** with the neighboring site signature following, in time, the site signature used to query the hash table **710**. For example, if the site signature **405**B is used to query the hash table **710**, then the candidate qualifier **640** compares the site signature **405**A with the previous hash key **732** and compares the site signature **405**C with the next hash key **734** for the candidate hash key **712** undergoing prequalification. If both comparisons are successful (e.g., the previous hash key **732** matches the previous site signature and the next hash key **734** matches the following site signature), then the candidate qualifier **640** indicates that prequalification for the particular candidate hash key **712** is successful and this key is retained for use in querying the block table **715** (or, in other words, the qualifier data **720** associated with the particular candidate hash key **712** is used to query the block table **715** in response to a successful prequalification of the particular candidate hash key **712** based on its associated value data **730**, which includes the previous hash key **732** and the next hash key **734**). Otherwise (e.g., if either comparison is unsuccessful), then the candidate qualifier **640** indicates that prequalification for the particular candidate hash key **712** is unsuccessful and this key is not retained for use in querying the block table **715** (or, in other words, the qualifier data **720** associated with the particular candidate hash key **712** is not used to query the block table **715** in response to an unsuccessful prequalification of the particular candidate hash key **712** based on its associated value data **730**, which includes the previous hash key **732** and the next hash key **734**). In some examples, the candidate qualifier **640** performs the preceding prequalification process for each candidate hash key **712** returned in response to a query of the hash table **710**.

[0066] The example crediting facility **115** of FIG. **6** includes an example block table query processor **645** to query the block table **715** stored in the block table storage **625** using the prequalified candidate hash keys **712** (e.g., reference signatures) identified by the candidate qualifier **640**. In the illustrated example, for a particular candidate hash key **712** returned by the hash table query processor **635** in response to a hash table query using a particular site signature (e.g., and prequalified by the candidate qualifier **640**), the block table query processor **645** can implement an appropriate database query (e.g., such as an HBase query) to query the block table **715** using the qualifier data **720** associated with the particular candidate hash key **712**. For example, the qualifier data **720** for the particular candidate hash key **712** includes the timestamp **722**, the source identifier **724** and the stream identifier **726**, which can be used to query the block table **715** to find a key **750** having a matching timestamp **752**, source identifier **754** and stream identifier **756**. In response to this block table query, the block table query processor **645** returns the key **750** having the timestamp **752**, the source identifier **754** and the stream identifier **756** that match the timestamp **722**, the source identifier **724** and the stream identifier **726** in the qualifier data **720** for the particular candidate hash key **712**. Additionally, the block table query processor **645** returns the current reference signature block **762**, the previous reference signature block **764** and the next reference signature block **766** included in the value data **760** for this block table entry.

[0067] In the illustrated example of FIG. **6**, the block table query processor **645** provides the current reference signature block **762**, the previous reference signature block **764** and the next reference signature block **766** obtained from the query of the block table **715** for a particular candidate hash key **712** to an example signature matcher **650**. The signature matcher **650** of the illustrated example compares a block of neighboring site signatures, which includes (e.g., is centered on, begins with, ends with, etc.) the particular site signature used to obtain the particular candidate hash key **712**, with an appropriately aligned, overlapping portion of the current reference signature block **762**, the previous reference signature block **764** and/or the next reference signature block **766** for the particular candidate hash key **712**. The appropriate alignment of the site signature block to the overlapping portion of the current, previous and/or next reference signature block(s) **762-766** is determined using the offset **728** included in the qualifier data **720** for the particular candidate hash key **712**.

[0068] The signature matcher **650** uses any appropriate metric to compare the site signature block with the overlapping portion of the current, previous and/or next reference signature block(s) **762-766**. For example, if the site signatures and reference signatures are all digital values represented by sequences of bits, the signature matcher **650** can use a POP count to count the number of bits that are different between the site signature block and the overlapping portion of the current, previous and/or next reference signature block(s) **762-766**. If the number of different bits satisfies/meets (e.g., is less than, or is less than or equal to) a threshold, the signature matcher **650** determines that the site signature block matches the overlapping portion of the current, previous and/or next reference signature block(s) **762-766**. Conversely, if the number of different bits fails to satisfy/meet (e.g., is greater than, or is greater than or equal to) the threshold, the signature matcher **650** determines that the site signature block fails to match the overlapping portion of the current, previous and/or next reference signature block(s) **762-766**.

[0069] An example matching operation capable of being performed by the example signature matcher **650** of FIG. **6** is illustrated in FIG. **8**. In the illustrated example of FIG. **8**, a first site signature **805** has been used to query the hash table **710** to obtain a candidate (e.g., and prequalified) hash key **712**. The reference signature corresponding to this candidate hash key **712** is denoted using the reference numeral **812** in the example of FIG. **8**. A query of the block table **715** using the qualifier data **720** for this candidate hash key **712** returns the current, previous and next reference signature block(s) **762-766**. The particular current, previous and next reference signature block(s) **762-766** for this candidate hash key **712** are denoted using the respective reference numerals **862**, **864** and **866** in the example of FIG. **8**.

[0070] The offset **728** included in the qualifier data **720** for this candidate hash key **712** specifies the location of the reference signature **812** (which corresponds to this candidate hash key **712**) in the current reference signature block **862**. Accordingly, the signature matcher **650** is able to align the site signature **805** (which was used to query the hash table **710**) with the reference signature **812** (which corresponds to this matching candidate hash key **712**) using the offset as shown in the example of FIG. **8**. Furthermore, the example signature matcher **650** forms, from the neighboring received site signatures preceding and following the site signature **805** in time, a site signature block **870** centered about the site signature **805** and containing a number of site signatures equal to the number of reference signatures (e.g., 64 signa-

tures, 128 signatures, etc.) included in one of the reference signature blocks **862**, **864** and **866**. The signature matcher **650** uses the offset **728** to align the site signature block **870** with the appropriate portion of the reference signature blocks **862**, **864** and **866** (e.g., which corresponds to a portion of the current and previous reference signature blocks **862** and **864** in the illustrated example). The signature matcher **650** then determines a POP count or some other comparison metric to determine whether the site signature block **870** matches the aligned, overlapping portion of the reference signature blocks **862**, **864** and **866**.

[0071] FIG. **8** also depicts example hash keys and example site signatures that could be used to prequalify the hash key corresponding to the reference signature **812**. In the illustrated example, the reference signature **882** corresponds to the previous hash key **732** and the reference signature **884** corresponds to the next hash key **734** included in the value data **730** for the hash key corresponding to the reference signature **812**. In the illustrated example, to prequalify the hash key **712** corresponding to the reference signature **812**, the example candidate qualifier **640** compares the reference signature **882** (or its corresponding hash key) with the neighboring site signature **892** preceding the site signature **805** in time, and compares the reference signature **884** (or its corresponding hash key) with the neighboring site signature **894** preceding the site signature **805** in time, as shown.

[0072] While example manners of implementing the example crediting facility **115** and, more generally, the example system **100** are illustrated in FIGS. **1-8**, one or more of the elements, processes and/or devices illustrated in FIGS. **1-8** may be combined, divided, re-arranged, omitted, eliminated and/or implemented in any other way. Further, the example media distributor(s) **105**, the example monitored site(s) **120**, the example MMS **130**, the example media device **205**, the example device meter **210**, the example people meter **215**, the example media receiver(s) **305**, the example signature generator(s) **310**, the example time determiner(s) **315**, the example data reporter **320**, the example MMS interface **605**, the example hash table populator **610**, the example block table populator **615**, the example hash table storage **620**, the example block table storage **625**, the example site interface **630**, the example hash table query processor **635**, the example candidate qualifier **640**, the example block table query processor **645**, the example signature matcher **650** and/or, more generally, the example crediting facility **115** and/or the example system **100** of FIGS. **1-8** may be implemented by hardware, software, firmware and/or any combination of hardware, software and/or firmware. Thus, for example, any of the example media distributor(s) **105**, the example monitored site(s) **120**, the example MMS **130**, the example media device **205**, the example device meter **210**, the example people meter **215**, the example media receiver(s) **305**, the example signature generator(s) **310**, the example time determiner(s) **315**, the example data reporter **320**, the example MMS interface **605**, the example hash table populator **610**, the example block table populator **615**, the example hash table storage **620**, the example block table storage **625**, the example site interface **630**, the example hash table query processor **635**, the example candidate qualifier **640**, the example block table query processor **645**, the example signature matcher **650** and/or, more generally, the example crediting facility **115** and/or the example system **100** could be implemented by one or more analog or digital circuit(s), logic circuits, programmable processor(s), application specific integrated circuit(s) (ASIC(s)), programmable logic device(s) (PLD(s)) and/or field programmable logic device(s) (FPLD(s)). When reading any of the apparatus or system claims of this patent to cover a purely software and/or firmware implementation, at least one of the example system **100**, the example crediting facility **115**, the example media distributor(s) **105**, the example monitored site(s) **120**, the example MMS **130**, the example media device **205**, the example device meter **210**, the example people meter **215**, the example media receiver(s) **305**, the example signature generator(s) **310**, the example time determiner(s) **315**, the example data reporter **320**, the example MMS interface **605**, the example hash table populator **610**, the example block table populator **615**, the example hash table storage **620**, the example block table storage **625**, the example site interface **630**, the example hash table query processor **635**, the example candidate qualifier **640**, the example block table query processor **645** and/or the example signature matcher **650** is/are hereby expressly defined to include a tangible computer readable storage device or storage disk such as a memory, a digital versatile disk (DVD), a compact disk (CD), a Blu-ray disk, etc. storing the software and/or firmware. Further still, the example system **100** and/or the example crediting facility **115** may include one or more elements, processes and/or devices in addition to, or instead of, those illustrated in FIGS. **1-8**, and/or may include more than one of any or all of the illustrated elements, processes and devices.

[0073] Flowcharts representative of example machine readable instructions for implementing the example system **100**, the example crediting facility **115**, the example media distributor(s) **105**, the example monitored site(s) **120**, the example MMS **130**, the example media device **205**, the example device meter **210**, the example people meter **215**, the example media receiver(s) **305**, the example signature generator(s) **310**, the example time determiner(s) **315**, the example data reporter **320**, the example MMS interface **605**, the example hash table populator **610**, the example block table populator **615**, the example hash table storage **620**, the example block table storage **625**, the example site interface **630**, the example hash table query processor **635**, the example candidate qualifier **640**, the example block table query processor **645** and/or the example signature matcher **650** are shown in FIGS. **9-11**. In these examples, the machine readable instructions comprise one or more programs for execution by a processor, such as the processor **1212** shown in the example processor platform **1200** discussed below in connection with FIG. **12**. The one or more programs, or portion(s) thereof, may be embodied in software stored on a tangible computer readable storage medium such as a CD-ROM, a floppy disk, a hard drive, a digital versatile disk (DVD), a Blu-ray Disk™, or a memory associated with the processor **1212**, but the entire program or programs and/or portions thereof could alternatively be executed by a device other than the processor **1212** and/or embodied in firmware or dedicated hardware (e.g., implemented by an ASIC, a PLD, an FPLD, discrete logic, etc.). Also, one or more of the machine readable instructions represented by the flowcharts of FIGS. **9-11** may be implemented manually. Further, although the example program(s) is(are) described with reference to the flowcharts illustrated in FIGS. **9-11**, many other methods of implementing the example system **100**, the example crediting facility **115**, the example media distributor(s) **105**, the example monitored

site(s) **120**, the example MMS **130**, the example media device **205**, the example device meter **210**, the example people meter **215**, the example media receiver(s) **305**, the example signature generator(s) **310**, the example time determiner(s) **315**, the example data reporter **320**, the example MMS interface **605**, the example hash table populator **610**, the example block table populator **615**, the example hash table storage **620**, the example block table storage **625**, the example site interface **630**, the example hash table query processor **635**, the example candidate qualifier **640**, the example block table query processor **645** and/or the example signature matcher **650** may alternatively be used. For example, with reference to the flowcharts illustrated in FIGS. **9-11**, the order of execution of the blocks may be changed, and/or some of the blocks described may be changed, eliminated, combined and/or subdivided into multiple blocks.

[0074] As mentioned above, the example processes of FIGS. **9-11** may be implemented using coded instructions (e.g., computer and/or machine readable instructions) stored on a tangible computer readable storage medium such as a hard disk drive, a flash memory, a read-only memory (ROM), a compact disk (CD), a digital versatile disk (DVD), a cache, a random-access memory (RAM) and/or any other storage device or storage disk in which information is stored for any duration (e.g., for extended time periods, permanently, for brief instances, for temporarily buffering, and/or for caching of the information). As used herein, the term tangible computer readable storage medium is expressly defined to include any type of computer readable storage device and/or storage disk and to exclude propagating signals and to exclude transmission media. As used herein, "tangible computer readable storage medium" and "tangible machine readable storage medium" are used interchangeably. Additionally or alternatively, the example processes of FIGS. **9-11** may be implemented using coded instructions (e.g., computer and/or machine readable instructions) stored on a non-transitory computer and/or machine readable medium such as a hard disk drive, a flash memory, a ROM, a CD, a DVD, a cache, a RAM and/or any other storage device or storage disk in which information is stored for any duration (e.g., for extended time periods, permanently, for brief instances, for temporarily buffering, and/or for caching of the information). As used herein, the term non-transitory computer readable medium is expressly defined to include any type of computer readable storage device and/or storage disk and to exclude propagating signals and to exclude transmission media. As used herein, when the phrase "at least" is used as the transition term in a preamble of a claim, it is open-ended in the same manner as the term "comprising" is open ended. Also, as used herein, the terms "computer readable" and "machine readable" are considered equivalent unless indicated otherwise.

[0075] A first example program **900** that may be executed to implement the example crediting facility **115** of FIGS. **1** and/or **6** is represented by the flowchart shown in FIG. **9**. With reference to the preceding figures and associated written descriptions, the example program **900** of FIG. **9** begins execution at block **905** at which the example MMS interface **605** of the crediting facility **115** receives reference data from the MMS **130** as described above, which includes the reference signature blocks **505**, the associated timestamps **510** and the media identifiers **515**. At block **910**, the example hash table populator **610** of the crediting facility **115** populates, as described above, the example hash table **710** with the reference data received at block **905**. At block **915**, the example block table populator **615** of the crediting facility **115** populates, as described above, the example block table **715** with the reference data received at block **905**.

[0076] In some examples, at block **920**, the crediting facility **115** performs hash table compaction to purge out-of-date reference data from the hash table **710**. Similarly, in some examples, at block **925** the crediting facility **115** performs block table compaction to purge out-of-date reference data from the block table **715**. For example, in an HBase implementation, the data included in entries of the hash table **710** and/or the block table **715** can be tagged with time-to-live values specifying a duration (e.g., such as a number of days, weeks, etc.) during which the data should be retained in the respective hash table **710** and/or block table **715**. Upon expiration of the time-to-live values, the crediting facility **115** purges the expired hash table data at block **920**, and purges the expired block table data at block **925**.

[0077] A second example program **1000** that may be executed to implement the example crediting facility **115** of FIGS. **1** and/or **6** is represented by the flowchart shown in FIG. **10**. With reference to the preceding figures and associated written descriptions, the example program **1000** of FIG. **10** begins execution at block **1005** at which the example site interface **630** of the crediting facility **115** receives metering data, which includes the site signatures **405** and the associated timestamps **410**, from a monitored site **120**, as described above. At block **1010**, the example hash table query processor **635** of the crediting facility **115** queries the hash table **710**, as described above, to retrieve candidate hash keys **712** (e.g., corresponding to respective reference signatures) matching a particular site signature. At block **1010**, the query of the hash table for a particular site signature returns the candidate hash keys **712** (e.g., corresponding to respective reference signatures) matching a particular site signature, as well as the qualifier data **720** and the value data **730** for these candidate hash keys **712**. At block **1015**, the example candidate qualifier **640** of the crediting facility performs candidate prequalification, as described above, to retain the prequalified candidate hash keys **712** to be used in subsequent signature matching processing (and to exclude the other candidate hash keys). Example machine readable instructions that may be used to implement the processing at block **1015** are illustrated in FIG. **11** and described in further detail below.

[0078] At block **1020**, the crediting facility **1020** configures the example block table query processor **645** and the example signature matcher **650** to process each prequalified candidate hash key **712** retained at block **1015**. For example, at block **1025**, the block table query processor **645** queries the block table **715**, as described above, using the qualifier data **720** for a given prequalified candidate hash key **712** (e.g., corresponding to a respective reference signature) to retrieve the current, previous and next reference signature blocks **762-766** corresponding to the given prequalified candidate hash key **712**. At block **1030**, the signature matcher **650** performs signature matching, as described above, to compare a portion of the current, previous and next reference signature blocks **762-766** corresponding to the given prequalified candidate hash key **712** with a site signature block containing the particular site signature used

to obtain the prequalified candidate hash key **712**. At block **1035**, the signature matcher **650** associates the site signatures in the site signature block with the reference media represented by the current, previous and next reference signature blocks **762-766** corresponding to the given prequalified candidate hash key **712** if the matching performed at block **1030** was successful. At block **1040**, the crediting facility **115** causes processing to continue until all prequalified candidate hash keys **712** have been processed. At block **1045**, the signature matcher **150** provides the successful signature matching results to further media monitoring process(es) (e.g., to credit the media monitored at the monitored site **120** as corresponding to the reference media represented by the reference signatures determined to match the site signatures at block **1035**).

[0079] An example program **1015**P that may be executed to implement the example candidate qualifier **640** of the example crediting facility **115** of FIG. **6**, and/or that may be used to perform the processing at block **1015** of FIG. **10**, is represented by the flowchart shown in FIG. **11**. With reference to the preceding figures and associated written descriptions, the example program **1015**P of FIG. **11** begins execution at block **1105** at which the candidate qualifier **640** obtains a group of candidate hash keys **712** (e.g., corresponding to respective reference signatures) that were returned in response to a query of the hash table **710** using a particular site signature, as described above. At block **1110**, the candidate qualifier **640** is configured to perform prequalification for each of the candidate hash keys **712**. For example, and as described above, at block **1115**, the candidate qualifier **640** compares the previous hash key **732** included in the value data **730** for a given candidate hash key **712** with the site signature preceding, in time, of the particular site signature used to query the hash table **710**. At block **1115**, the candidate qualifier **640** also compares the next hash key **736** **732** included in the value data **730** for a given candidate hash key **712** with the site signature following, in time, the particular site signature used to query the hash table **710**.

[0080] At block **1120**, the candidate qualifier **640** determines if both comparisons performed at block **1115** were successful (e.g., if the previous hash key **732** matched the previous site signature and the next hash key **734** matched the subsequent site signature). If both comparisons were successful (block **1120**), at block **1125** the candidate qualifier **640** indicates that the given candidate hash key **712** is prequalified for use in further signature matching processing for the current site signature. However, if either comparisons was unsuccessful (block **1120**), at block **1125** the candidate qualifier **640** causes the given candidate hash key **712** to be excluded from use in further signature matching processing for the current site signature. At block **1135**, the candidate qualifier **640** continues performing prequalification processing until all candidate hash keys **712** have been processed. At block **1140**, the candidate qualifier **640** returns information identifying the resulting prequalified candidate hash keys **712** (e.g., which correspond to respective reference signatures).

[0081] FIG. **12** is a block diagram of an example processor platform **1200** capable of executing the instructions of FIGS. **9-11** to implement the example system **100**, the example crediting facility **115**, the example media distributor(s) **105**, the example monitored site(s) **120**, the example MMS **130**, the example media device **205**, the example device meter **210**, the example people meter **215**, the example media receiver(s) **305**, the example signature generator(s) **310**, the example time determiner(s) **315**, the example data reporter **320**, the example MMS interface **605**, the example hash table populator **610**, the example block table populator **615**, the example hash table storage **620**, the example block table storage **625**, the example site interface **630**, the example hash table query processor **635**, the example candidate qualifier **640**, the example block table query processor **645** and/or the example signature matcher **650** of FIGS. **1-8**. The processor platform **1200** can be, for example, a server, a personal computer, a mobile device (e.g., a cell phone, a smart phone, a tablet such as an iPad™), a personal digital assistant (PDA), an Internet appliance, a DVD player, a CD player, a digital video recorder, a Blu-ray player, a gaming console, a personal video recorder, a set top box a digital camera, or any other type of computing device.

[0082] The processor platform **1200** of the illustrated example includes a processor **1212**. The processor **1212** of the illustrated example is hardware. For example, the processor **1212** can be implemented by one or more integrated circuits, logic circuits, microprocessors or controllers from any desired family or manufacturer.

[0083] The processor **1212** of the illustrated example includes a local memory **1213** (e.g., a cache). The processor **1212** of the illustrated example is in communication with a main memory including a volatile memory **1214** and a non-volatile memory **1216** via a link **1218**. The link **1218** may be implemented by a bus, one or more point-to-point connections, etc., or a combination thereof. The volatile memory **1214** may be implemented by Synchronous Dynamic Random Access Memory (SDRAM), Dynamic Random Access Memory (DRAM), RAMBUS Dynamic Random Access Memory (RDRAM) and/or any other type of random access memory device. The non-volatile memory **1216** may be implemented by flash memory and/or any other desired type of memory device. Access to the main memory **1214**, **1216** is controlled by a memory controller.

[0084] The processor platform **1200** of the illustrated example also includes an interface circuit **1220**. The interface circuit **1220** may be implemented by any type of interface standard, such as an Ethernet interface, a universal serial bus (USB), and/or a PCI express interface.

[0085] In the illustrated example, one or more input devices **1222** are connected to the interface circuit **1220**. The input device(s) **1222** permit(s) a user to enter data and commands into the processor **1212**. The input device(s) can be implemented by, for example, an audio sensor, a microphone, a camera (still or video), a keyboard, a button, a mouse, a touchscreen, a track-pad, a trackball, a trackbar (such as an isopoint), a voice recognition system and/or any other human-machine interface. Also, many systems, such as the processor platform **1200**, can allow the user to control the computer system and provide data to the computer using physical gestures, such as, but not limited to, hand or body movements, facial expressions, and face recognition.

[0086] One or more output devices **1224** are also connected to the interface circuit **1220** of the illustrated example. The output devices **1224** can be implemented, for example, by display devices (e.g., a light emitting diode (LED), an organic light emitting diode (OLED), a liquid crystal display, a cathode ray tube display (CRT), a touchscreen, a tactile output device, a light emitting diode (LED), a printer and/or speakers). The interface circuit **1220** of the

illustrated example, thus, typically includes a graphics driver card, a graphics driver chip or a graphics driver processor.

[0087] The interface circuit **1220** of the illustrated example also includes a communication device such as a transmitter, a receiver, a transceiver, a modem and/or network interface card to facilitate exchange of data with external machines (e.g., computing devices of any kind) via a network **1226** (e.g., an Ethernet connection, a digital subscriber line (DSL), a telephone line, coaxial cable, a cellular telephone system, etc.).

[0088] The processor platform **1200** of the illustrated example also includes one or more mass storage devices **1228** for storing software and/or data. Examples of such mass storage devices **1228** include floppy disk drives, hard drive disks, compact disk drives, Blu-ray disk drives, RAID (redundant array of independent disks) systems, and digital versatile disk (DVD) drives.

[0089] Coded instructions **1232** corresponding to the instructions of FIGS. **9-11** may be stored in the mass storage device **1228**, in the volatile memory **1214**, in the non-volatile memory **1216**, in the local memory **1213** and/or on a removable tangible computer readable storage medium, such as a CD or DVD **1236**.

[0090] Example methods, apparatus, systems and articles of manufacture to perform signature retrieval and matching for media monitoring have been disclosed herein. Further example techniques to identify media using hash keys, which can be employed in conjunction with the examples provided herein, are disclosed in U.S. Provisional Application Ser. No. 61/976,238 (Attorney Docket No. 20004/103754US01), entitled "METHODS AND APPARATUS TO IDENTIFY MEDIA USING HASH KEYS" and filed on Apr. 7, 2014, which is hereby incorporated by reference in its entirety.

[0091] Although certain example methods, apparatus and articles of manufacture have been disclosed herein, the scope of coverage of this patent is not limited thereto. On the contrary, this patent covers all methods, apparatus and articles of manufacture fairly falling within the scope of the claims of this patent.

What is claimed is:

1. An apparatus comprising:

a hash table populator to:

store hash keys representative of respective reference signatures included in a first reference signature block associated with first reference media in respective entries of a hash table in a database; and

store first qualifier data in a first entry of the hash table corresponding to a first hash key, the first qualifier data including a timestamp, a first offset, and an identifier associated with a first reference signature represented by the first hash key; and

a block table populator to:

store a first block table key corresponding to the first reference signature block in a first entry of a block table in the database, the first block table key including the timestamp and the identifier; and

store the first reference signature block, a preceding reference signature block relative to the first reference signature block and a subsequent reference signature block relative to the first reference signature block in the first entry of the block table; and

a signature matcher to access the hash table and the block table to retrieve candidate reference signatures to compare with site signatures representative of monitored media to identify the monitored media.

2. The apparatus as defined in claim **1**, wherein the hash table populator is further to store, in the first entry of the hash table, a second hash key representative of a second reference signature preceding the first reference signature in the first reference signature block and a third hash key representative of a third reference signature following the first reference signature in the first reference signature block.

3. The apparatus as defined in claim **1**, wherein the first offset corresponds to a position of the first reference signature in the first reference block.

4. The apparatus as defined in claim **1**, wherein the hash table is stored in a first type of memory and the block table is stored in a second, different type of memory.

5. The apparatus as defined in claim **4**, wherein the first type of memory is volatile memory and the second type of memory is non-volatile memory.

6. The apparatus as defined in claim **1**, further including a processor to:

perform hash table compaction to purge out-of-date reference data from the hash table; and

perform block table compaction to purge out-of-date reference data from the block table.

7. The apparatus as defined in claim **6**, wherein the processor is to perform at least one of the hash table compaction or the block table compaction based on a time-to-live value.

8. A method to credit media, the method comprising:

storing hash keys representative of respective reference signatures included in a first reference signature block associated with first reference media in respective entries of a hash table in a database;

storing, by executing an instruction with a processor, first qualifier data in a first entry of the hash table corresponding to a first hash key, the first qualifier data including a timestamp, a first offset, and an identifier associated with a first reference signature represented by the first hash key;

storing, by executing an instruction with the processor, a first block table key corresponding to the first reference signature block in a first entry of a block table in the database, the first block table key including the timestamp and the identifier; and

storing the first reference signature block, a preceding reference signature block relative to the first reference signature block and a subsequent reference signature block relative to the first reference signature block in the first entry of a block table; and

accessing, by executing an instruction with the processor, the hash table and block table to retrieve candidate reference signatures to compare with site signatures representative of monitored media to identify the monitored media.

9. The method as defined in claim **8**, further including storing, in the first entry of the hash table, a second hash key representative of a second reference signature preceding the first reference signature in the first reference signature block and a third hash key representative of a third reference signature following the first reference signature in the first reference signature block.

10. The method as defined in claim **8**, wherein the first offset corresponds to a position of the first reference signature in the first reference block.

11. The method as defined in claim **8**, wherein the hash table is stored in a first type of memory and the block table is stored in a second, different type of memory.

12. The method as defined in claim **11**, wherein the first type of memory is volatile memory and the second type of memory is non-volatile memory.

13. The method as defined in claim **8**, further including:

performing hash table compaction to purge out-of-date reference data from the hash table; and

performing block table compaction to purge out-of-date reference data from the block table.

14. The method as defined in claim **13**, wherein at least one of the performing of the hash table compaction and the performing of the block table compaction is performed based on a time-to-live value.

15. A tangible computer readable storage medium comprising machine readable instructions which, when executed, cause a machine to at least:

store hash keys representative of respective reference signatures included in a first reference signature block associated with first reference media in respective entries of a hash table in a database; and

store first qualifier data in a first entry of the hash table corresponding to a first hash key, the first qualifier data including a timestamp, a first offset, and an identifier associated with a first reference signature represented by the first hash key;

store a first block table key corresponding to the first reference signature block in a first entry of a block table in the database, the first block table key including the timestamp and the identifier; and

store the first reference signature block, a preceding reference signature block relative to the first reference signature block and a subsequent reference signature block relative to the first reference signature block in the first entry of a block table; and

access the hash table and block table to retrieve candidate reference signatures to compare with site signatures representative of monitored media to identify the monitored media.

16. The storage medium as defined in claim **15**, wherein the machine readable instructions, when executed, further cause the machine to store, in the first entry of the hash table, a second hash key representative of a second reference signature preceding the first reference signature in the first reference signature block and a third hash key representative of a third reference signature following the first reference signature in the first reference signature block.

17. The storage medium as defined in claim **15**, wherein the first offset corresponds to a position of the first reference signature in the first reference block.

18. The storage medium as defined in claim **15**, wherein the hash table is stored in a first type of memory and the block table is stored in a second, different type of memory.

19. The storage medium as defined in claim **18**, wherein the first type of memory is volatile memory and the second type of memory is non-volatile memory.

20. The storage medium as defined in claim **15**, wherein the machine readable instructions, when executed, further cause the machine to:

perform hash table compaction to purge out-of-date reference data from the hash table; and

perform block table compaction to purge out-of-date reference data from the block table.

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