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(54) **DISTRIBUTED PROCESSING, STORAGE, AND TRANSMISION OF MULTIMEDIA INFORMATION**

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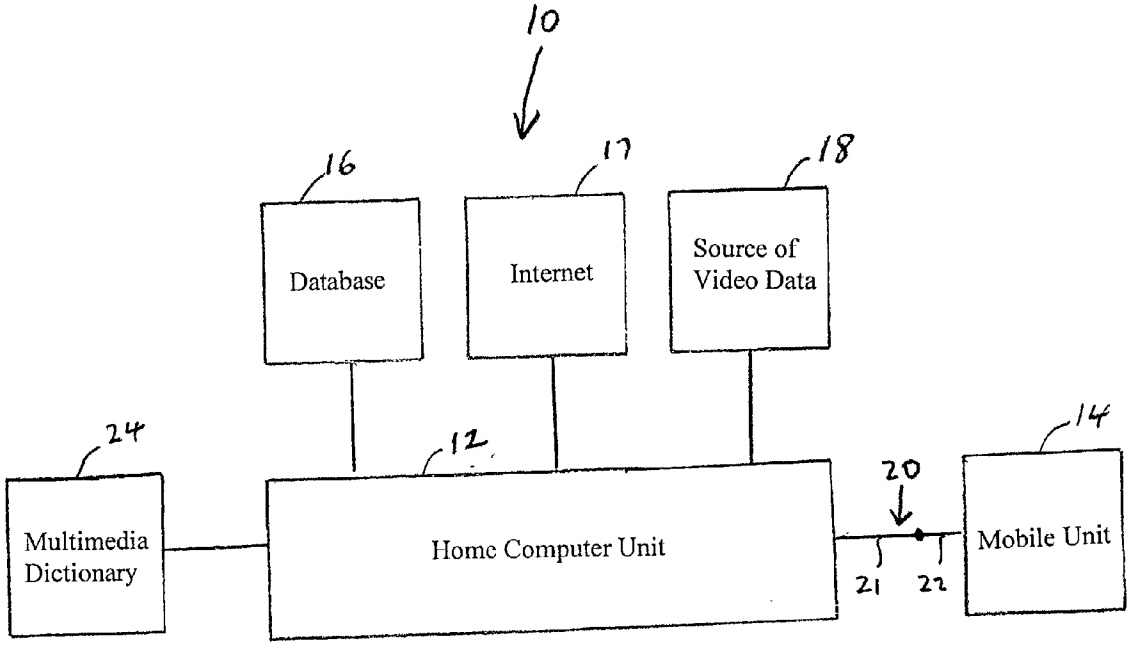
(57) **ABSTRACT**

A system and method for communicating and processing data. A home computer unit engages in two-way communication with a mobile unit over a communication path having a wireless portion. The home computer unit receives a signal from the mobile unit over the communication path. The signal comprises a request by the mobile unit for information from the home computer unit. The home computer unit extracts the requested information from a data source. If the extracted requested information does not satisfy a bandwidth constraint relating to the communication path or does not fit within available memory of the mobile unit, then the home computer unit restructures the requested information into downsized information such that the downsized information satisfies the bandwidth constraint and fits within the available memory of the mobile unit. Then, the home computer unit transmits the downsized information to the mobile unit over the communication path.



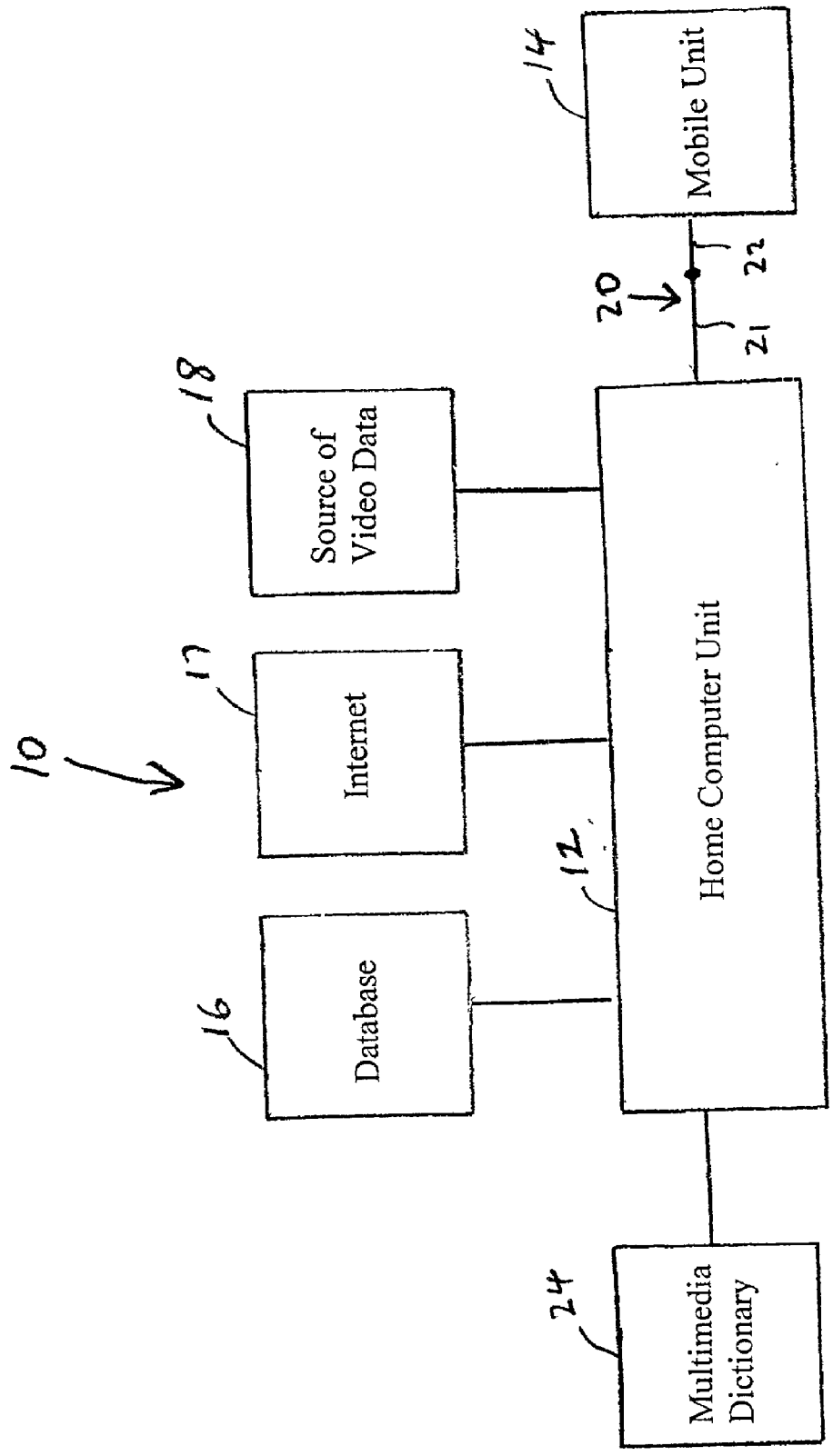

10
Home Computer Unit
12
Internet
17
Database
16
Source of Video Data
18
Mobile Unit
14
20
21
22
Multimedia Dictionary
24

FIG. 1

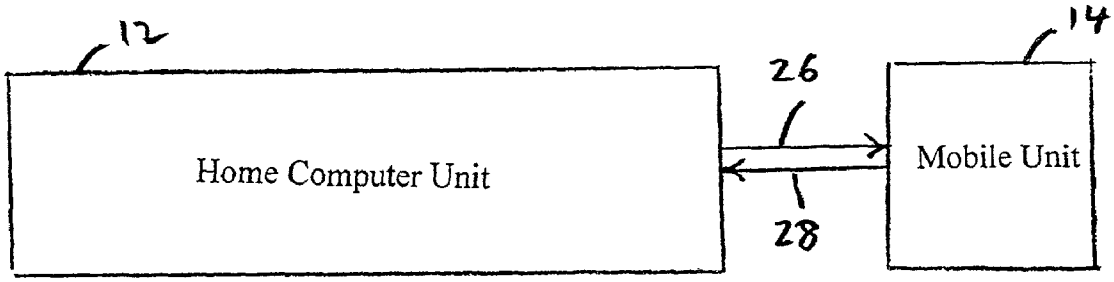

12
14
26
Home Computer Unit
Mobile Unit
28

FIG. 2

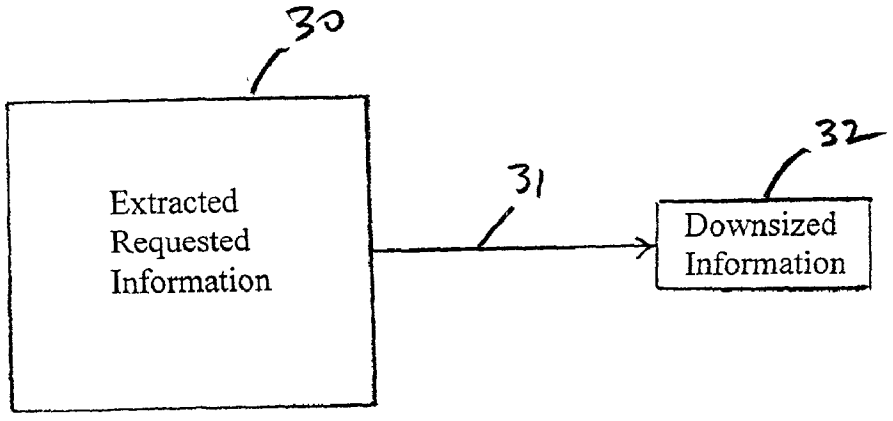

30
Extracted
Requested
Information
31
32
Downsized
Information

FIG. 3

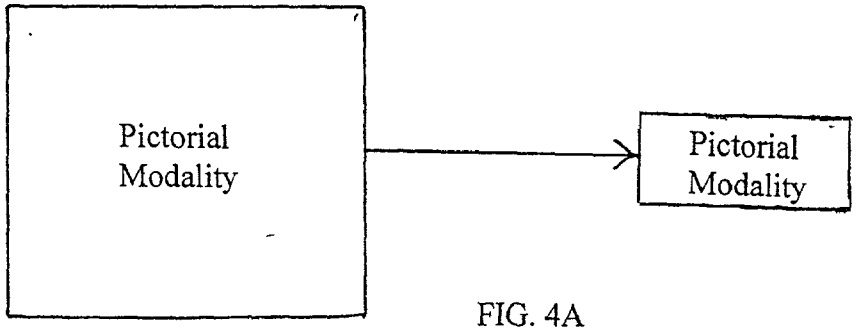


FIG. 4A

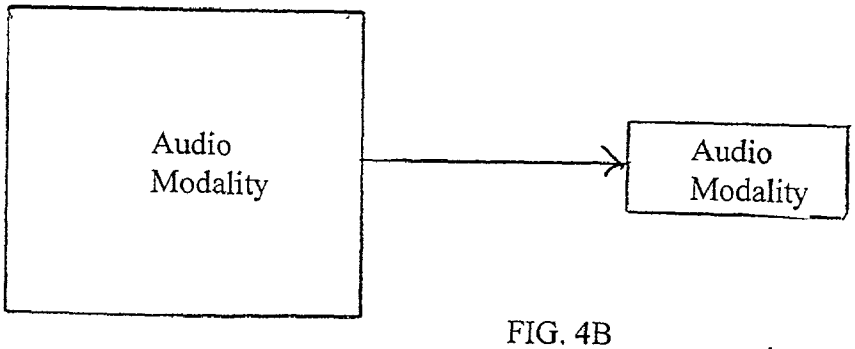


FIG. 4B

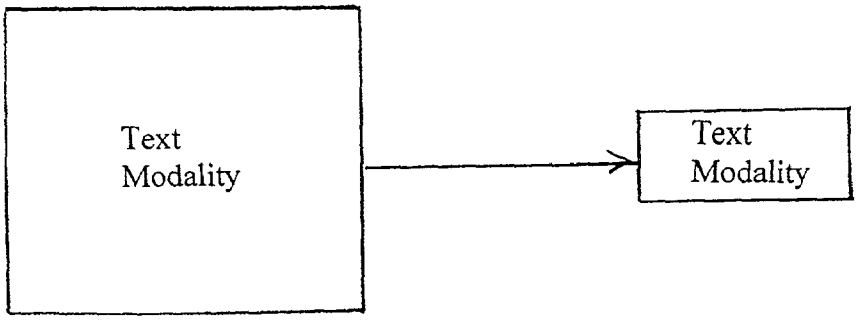


FIG. 4C

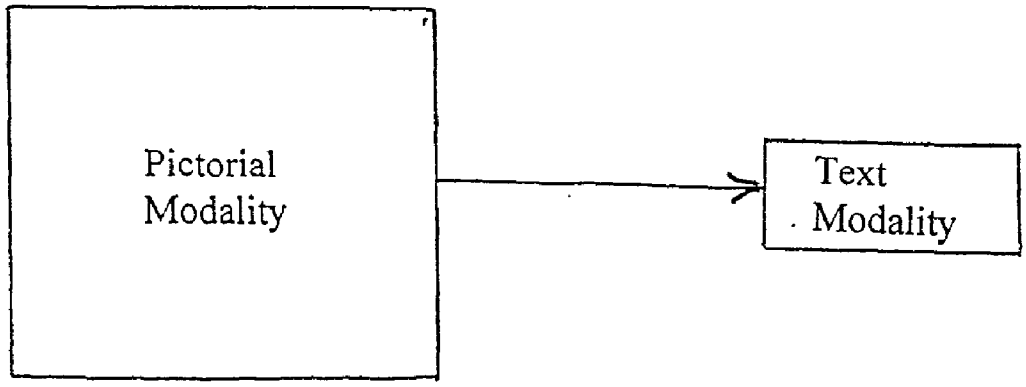

Pictorial
Modality
Text
Modality

FIG. 5A

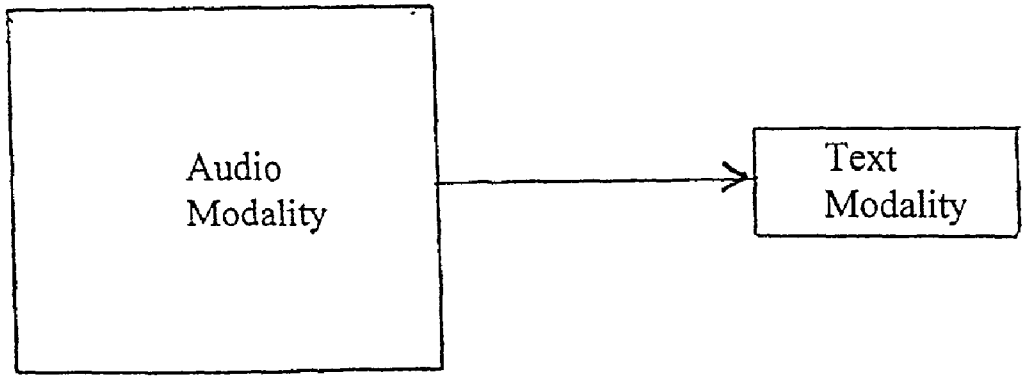

Audio
Modality
Text
Modality

FIG. 5B

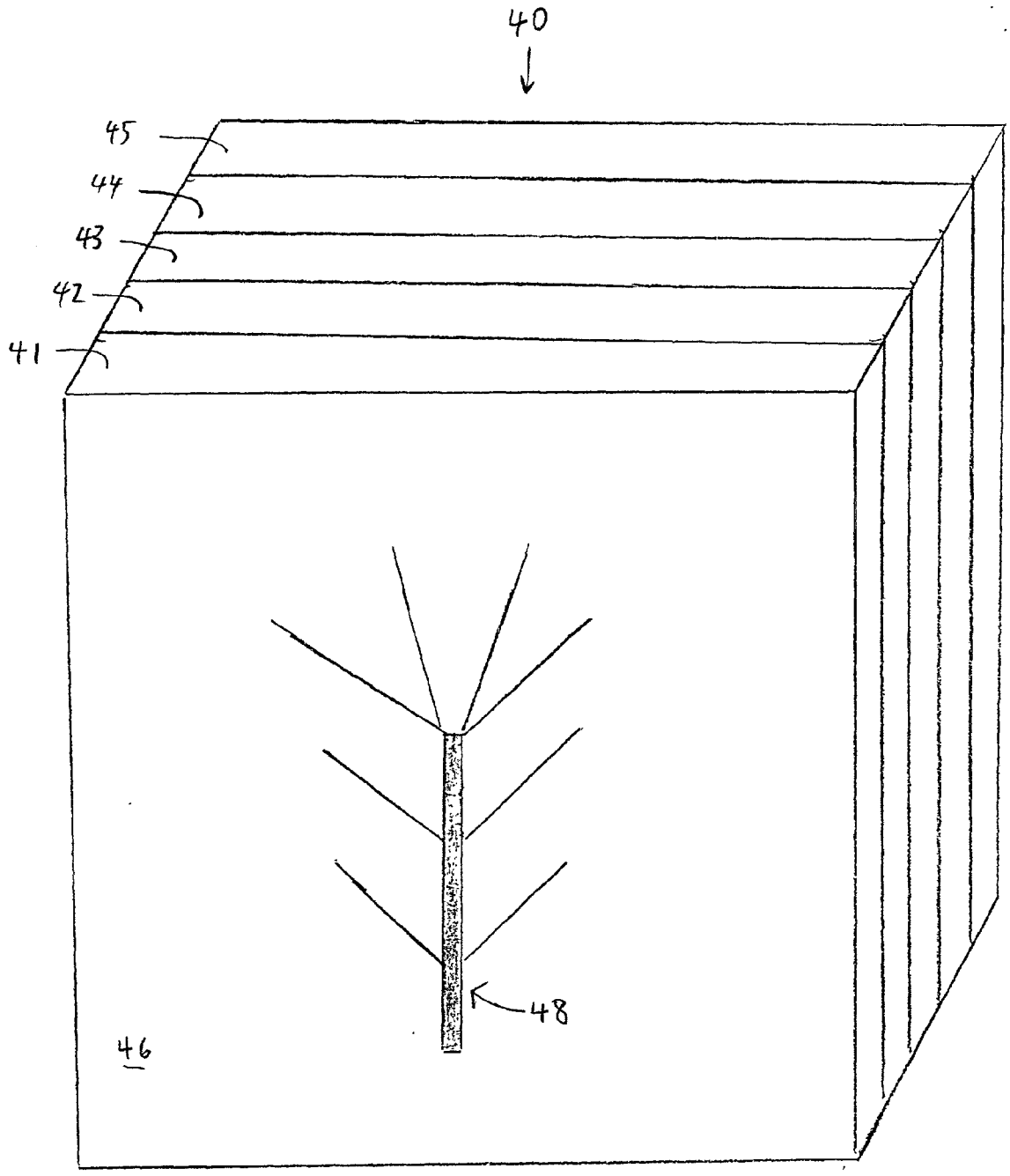


FIG. 6

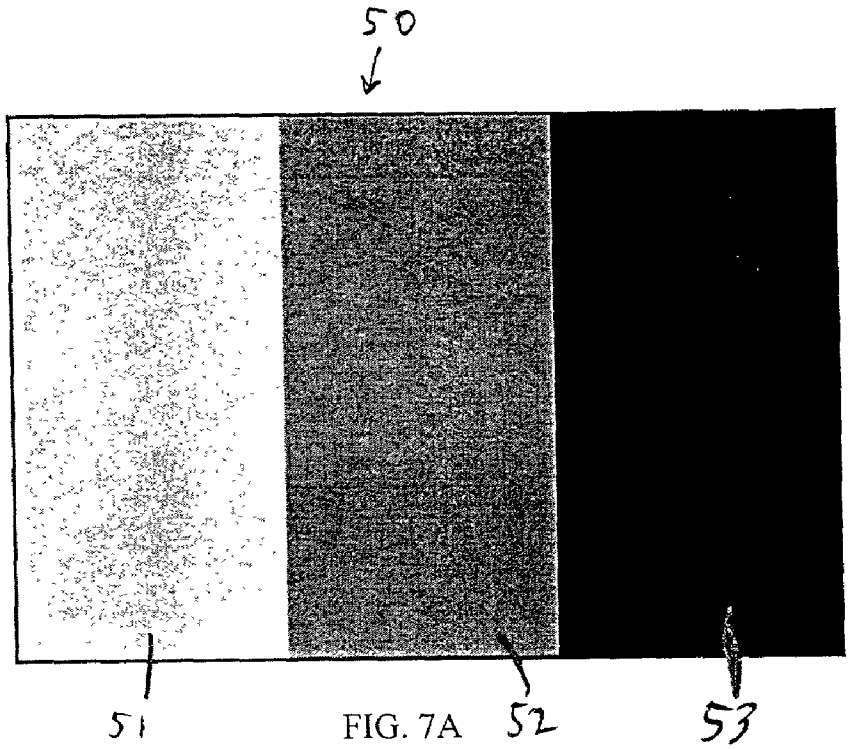


FIG. 7A

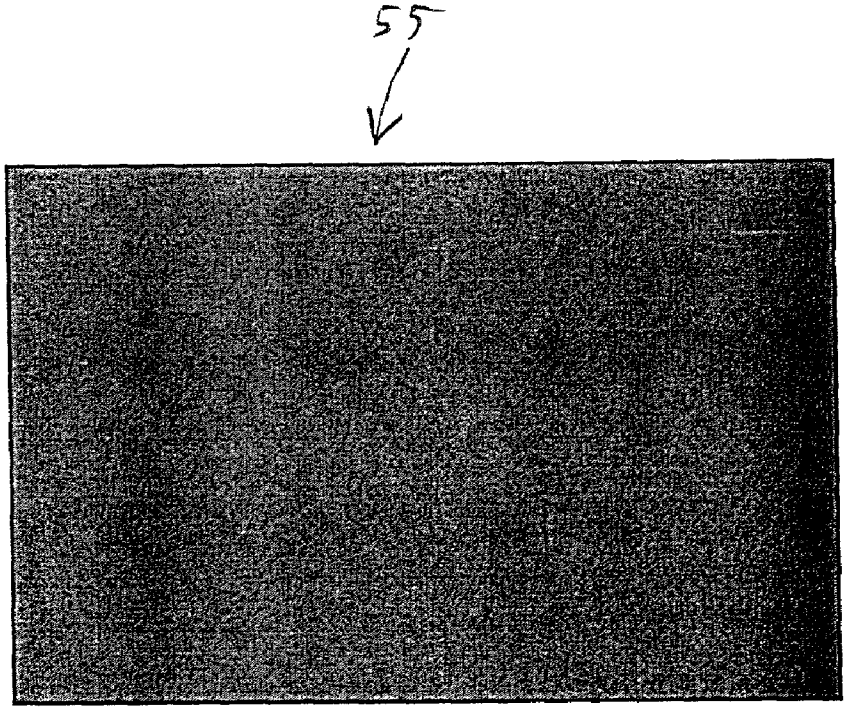


FIG. 7B

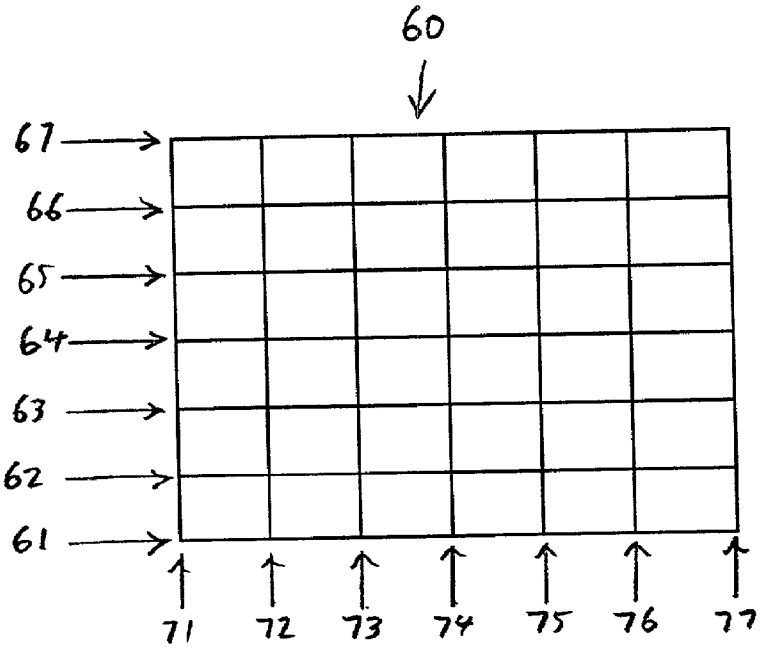


FIG. 8A

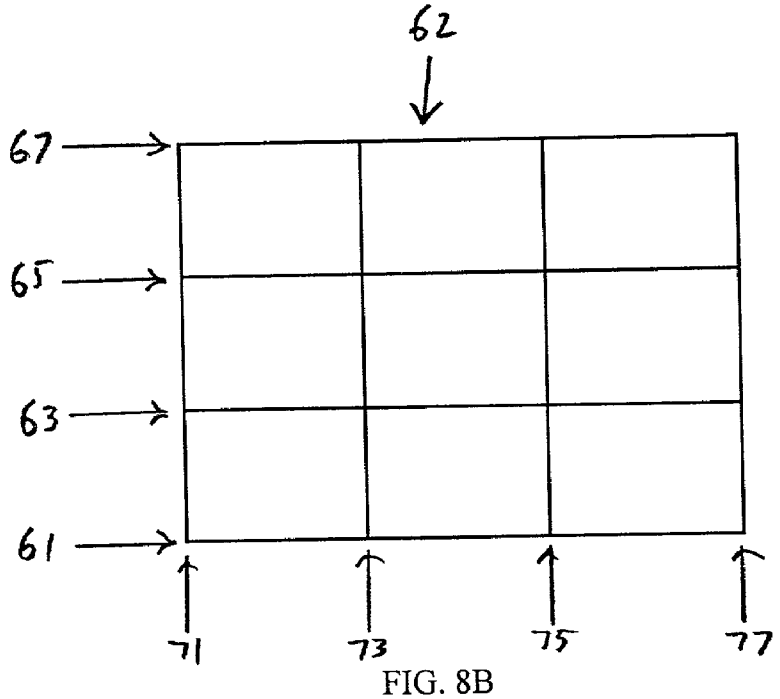


FIG. 8B

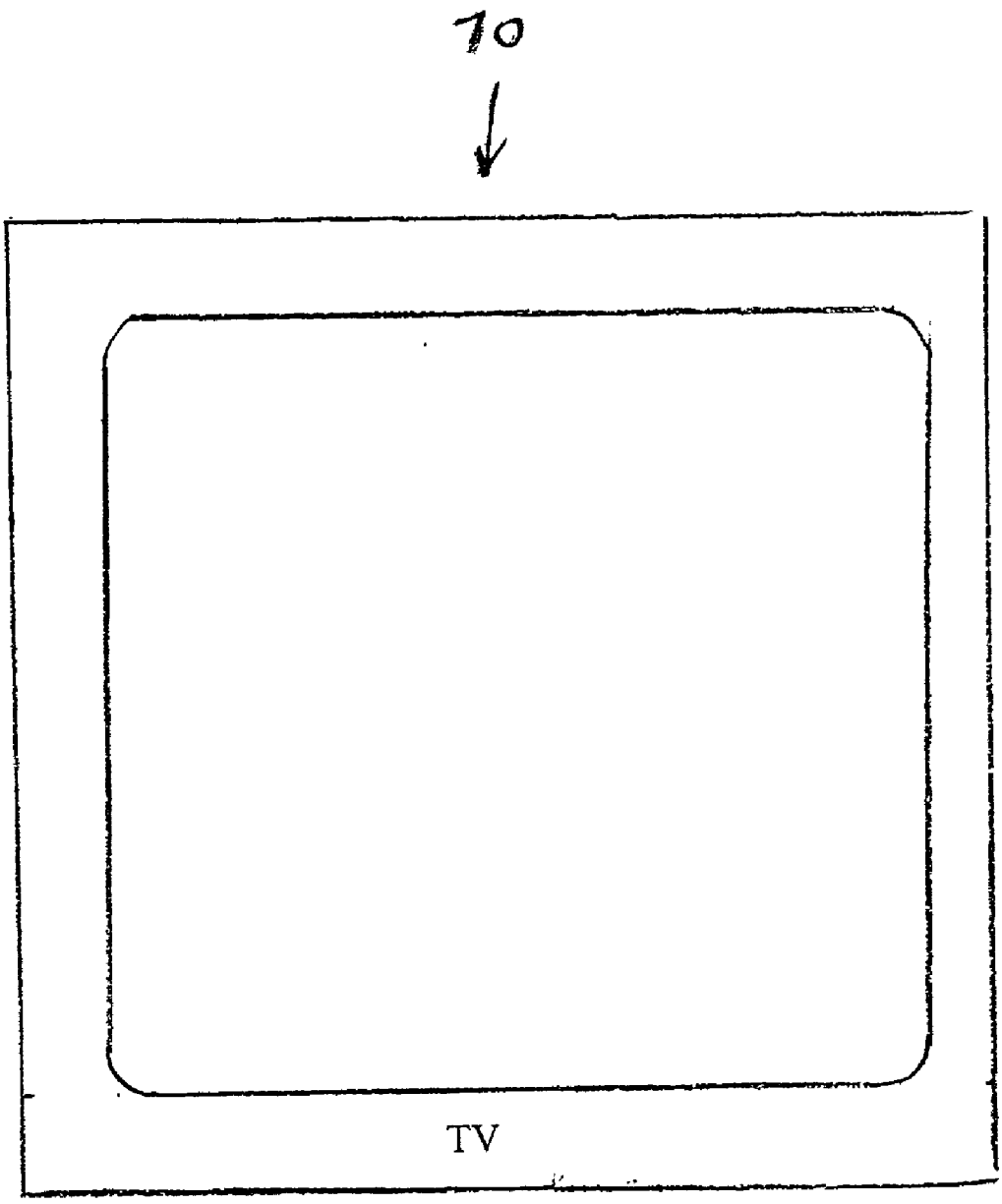


FIG. 9

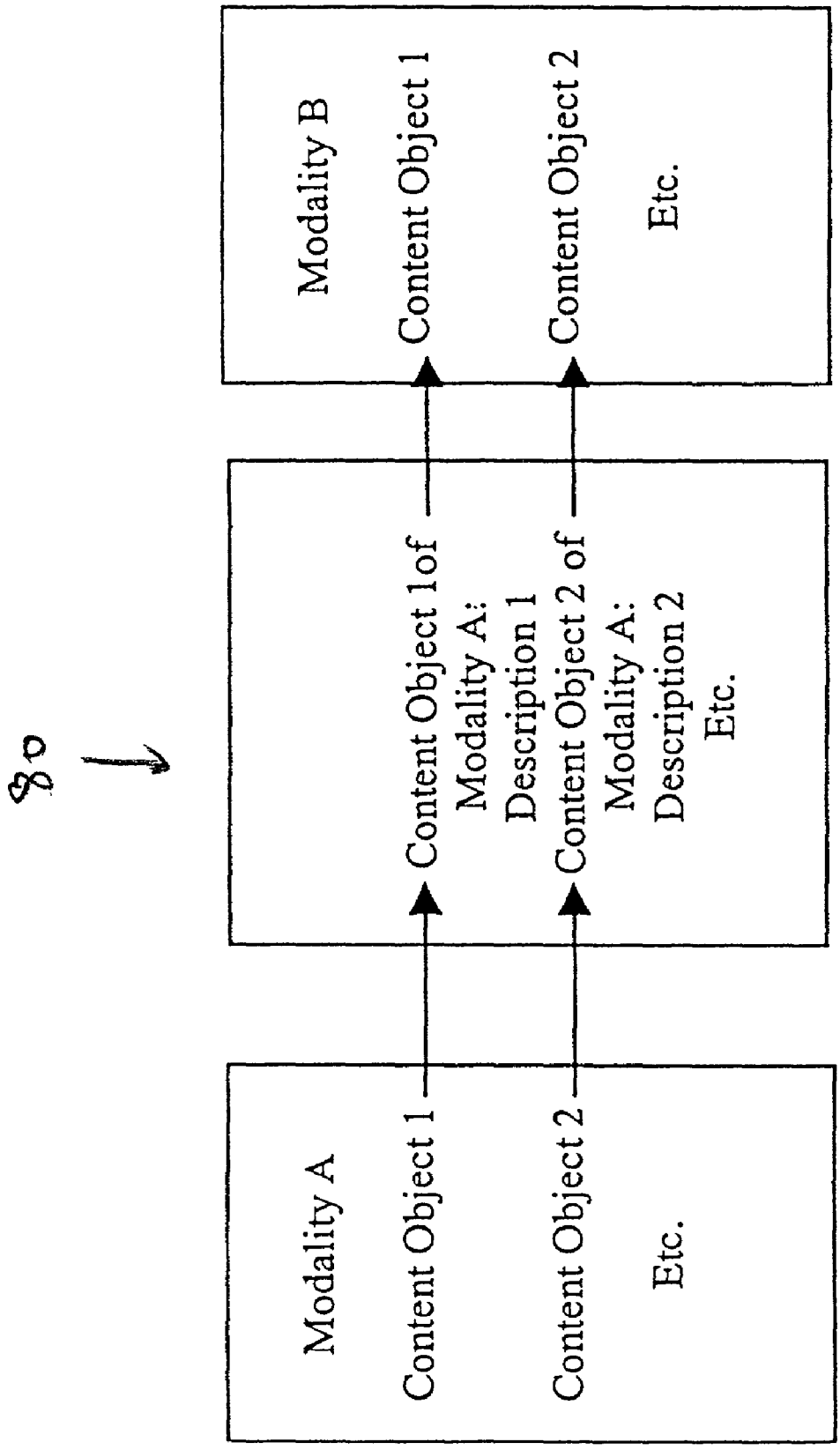

80
Modality A
Content Object 1
Content Object 2
Etc.
Content Object 1of Modality A: Description 1
Content Object 2 of Modality A: Description 2
Etc.
Modality B
Content Object 1
Content Object 2
Etc.

FIG. 10

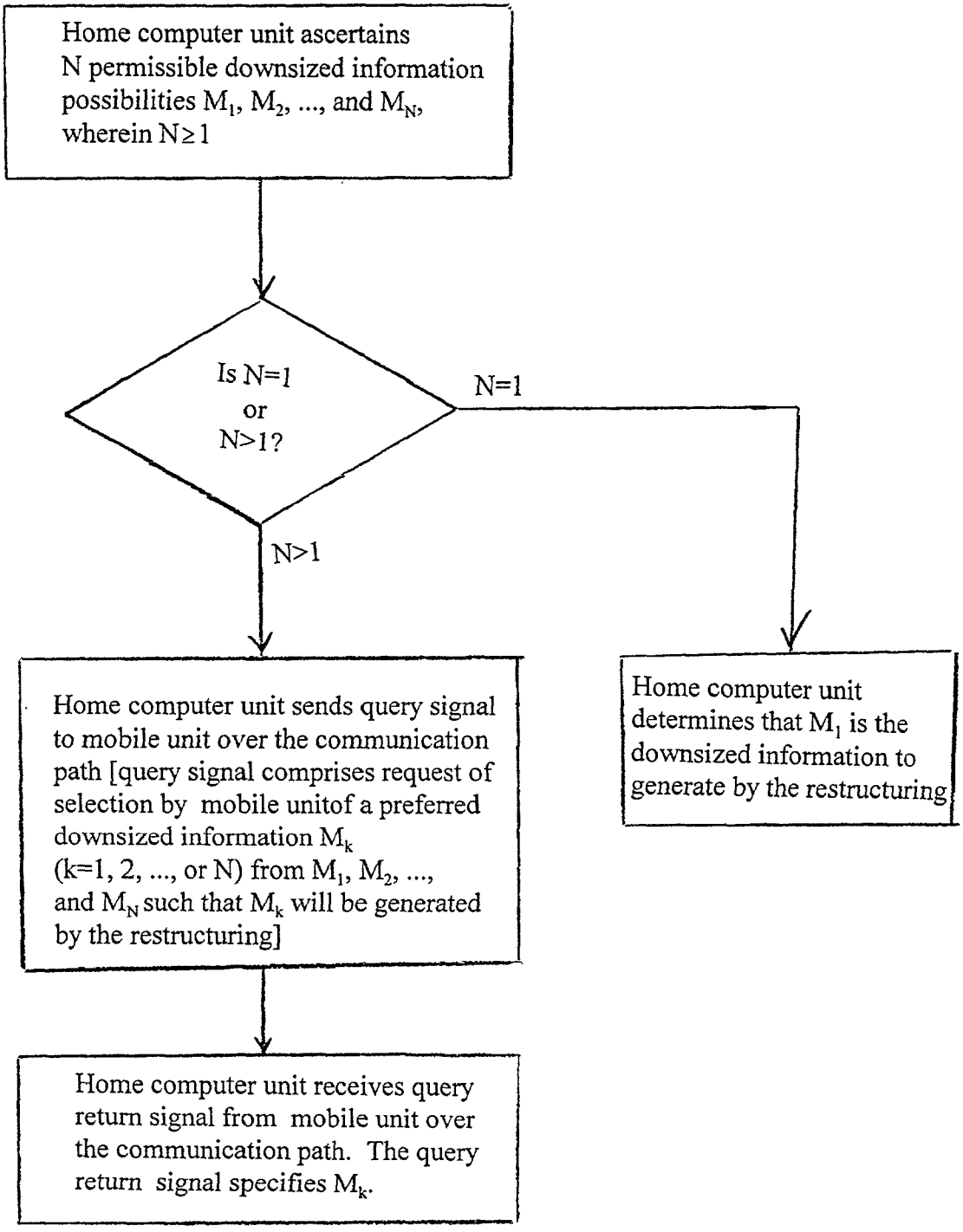

Home computer unit ascertains N permissible downsized information possibilities M_1, M_2, ..., and M_N, wherein $N \geq 1$
Is N=1 or N>1?
N=1
N>1
Home computer unit sends query signal to mobile unit over the communication path [query signal comprises request of selection by mobile unitof a preferred downsized information M_k (k=1, 2, ..., or N) from M_1, M_2, ..., and M_N such that M_k will be generated by the restructuring]
Home computer unit determines that M_1 is the downsized information to generate by the restructuring
Home computer unit receives query return signal from mobile unit over the communication path. The query return signal specifies M_k.

FIG. 11

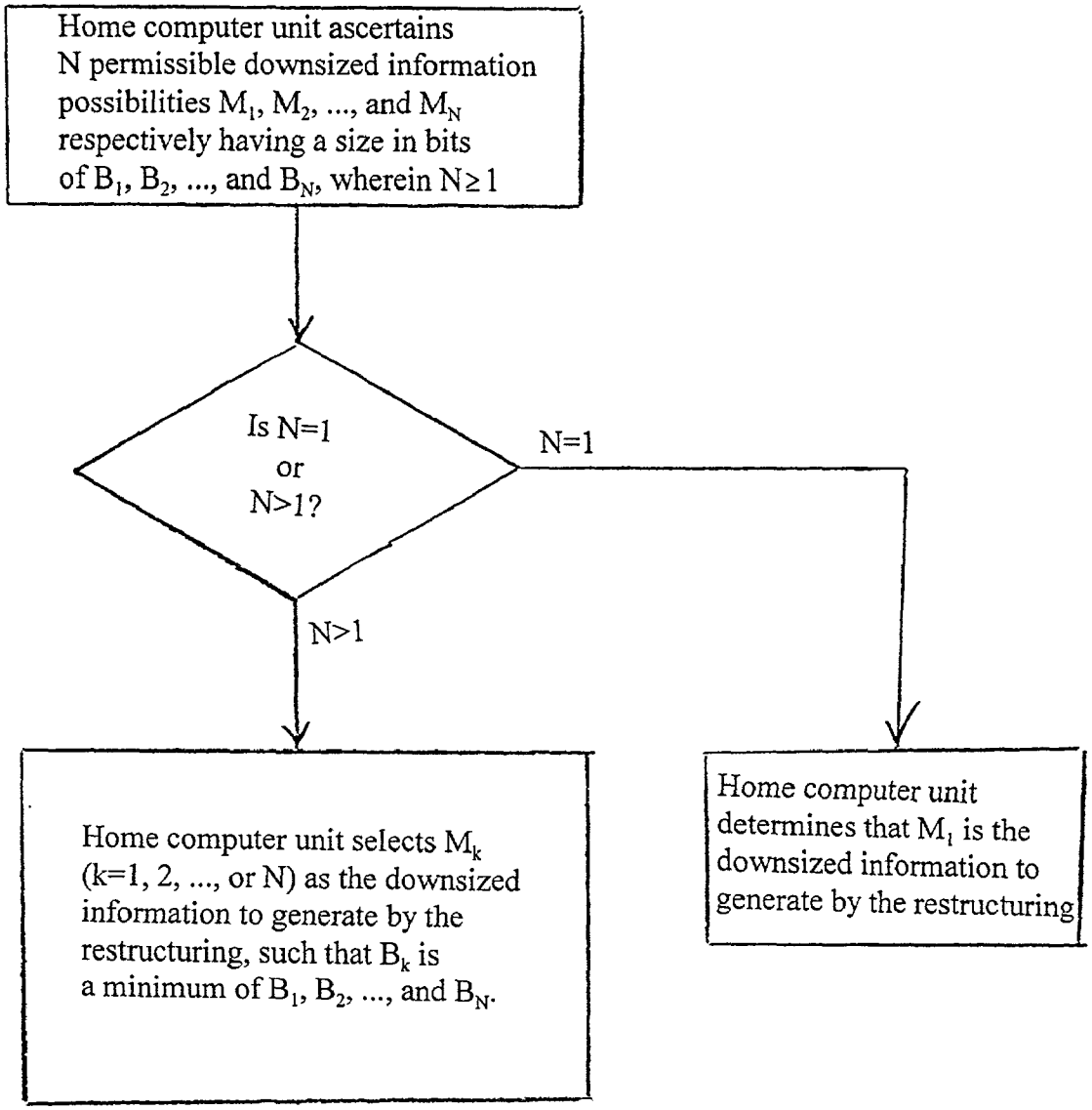

Home computer unit ascertains N permissible downsized information possibilities M_1, M_2, ..., and M_N respectively having a size in bits of B_1, B_2, ..., and B_N, wherein $N \geq 1$
Is N=1 or N>1?
N=1
N>1
Home computer unit selects M_k (k=1, 2, ..., or N) as the downsized information to generate by the restructuring, such that B_k is a minimum of B_1, B_2, ..., and B_N.
Home computer unit determines that M_1 is the downsized information to generate by the restructuring

FIG. 12

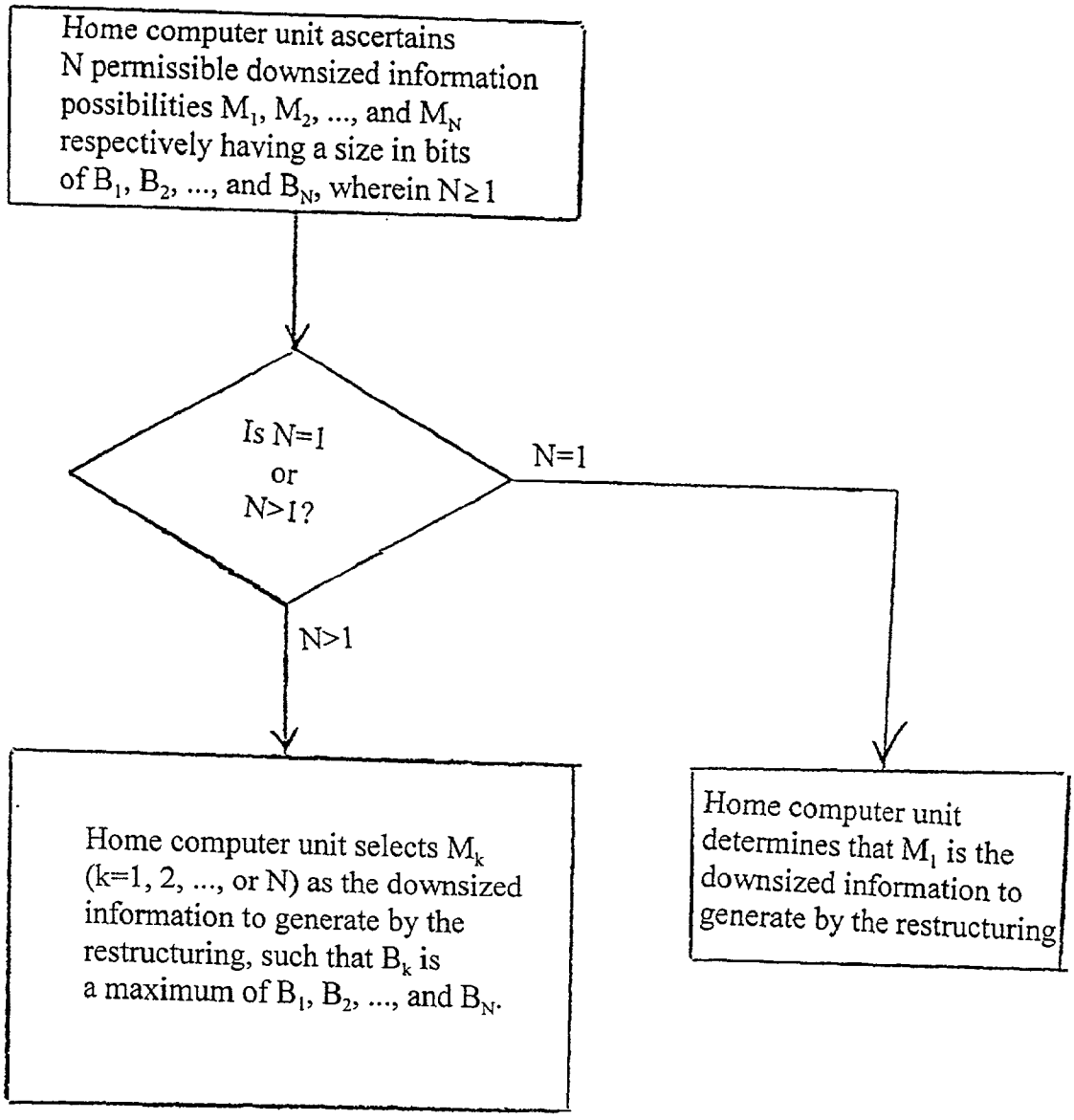

Home computer unit ascertains N permissible downsized information possibilities M_1, M_2, ..., and M_N respectively having a size in bits of B_1, B_2, ..., and B_N, wherein $N \geq 1$
Is N=1 or N>1?
N=1
N>1
Home computer unit selects M_k (k=1, 2, ..., or N) as the downsized information to generate by the restructuring, such that B_k is a maximum of B_1, B_2, ..., and B_N.
Home computer unit determines that M_1 is the downsized information to generate by the restructuring

FIG. 13

DISTRIBUTED PROCESSING, STORAGE, AND TRANSMISION OF MULTIMEDIA INFORMATION

BACKGROUND OF THE INVENTION

[0001] 1. Technical Field

[0002] The present invention relates to a system and method for communicating A system and method for communicating and processing data. A home computer unit engages in two-way communication with a mobile unit over a communication path having a wireless portion. The home computer unit receives a signal from the mobile unit over the communication path. The signal comprises a request by the mobile unit for information from the home computer unit. The home computer unit extracts the requested information from a data source. If the extracted requested information does not satisfy a bandwidth constraint relating to the communication path or does not fit within available memory of the mobile unit, then the home computer unit restructures the requested information into downsized information such that the downsized information satisfies the bandwidth constraint and fits within the available memory of the mobile unit. Then, the home computer unit transmits the downsized information to the mobile unit over the communication path. data, and more particularly to a system and method of communicating information between a home computer unit and a mobile unit.

[0003] 2. Related Art

[0004] Data communication between disparate computer systems may have incompatibilities that cause such data communication to be inefficient, inaccurate, or too slow. Thus, there is a need for a system and method for communicating data between disparate computer systems in such a way that such data communication is efficient, accurate, and not too slow.

SUMMARY OF THE INVENTION

[0005] The present invention provides a system for communication and processing of data, comprising a home computer unit,

[0006] wherein the home computer unit is adapted to engage in two-way communication with a mobile unit over a communication path,

[0007] wherein a portion of the communication path is wireless,

[0008] wherein the home computer unit is adapted to receive at least one signal sent by the mobile unit to the home computer unit over the communication path,

[0009] wherein the at least one signal comprises a request by the mobile unit for information from the home computer unit,

[0010] wherein the home computer unit is adapted to extract the requested information from a data source, and

[0011] wherein if the extracted requested information does not satisfy a bandwidth constraint relating to the communication path or does not fit within available memory of the mobile unit, then:

[0012] the home computer unit is adapted to effectuate a restructuring of the extracted requested information into downsized information such that the downsized information satisfies the bandwidth constraint and fits within the available memory of the mobile unit, and

[0013] the home computer unit is adapted to transmit the downsized information to the mobile unit over the communication path.

[0014] The present invention provides a method for communicating and processing data, comprising

[0015] providing a home computer unit;

[0016] engaging, by the home computer unit, in two-way communication with a mobile unit over a communication path, wherein a portion of the communication path is wireless;

[0017] receiving, by the home computer unit, at least one signal sent by the mobile unit to the home computer unit over the communication path such that the at least one signal comprises a request by the mobile unit for information from the home computer unit;

[0018] extracting, by the home computer unit, the requested information from a data source, wherein if the extracted requested information does not satisfy a bandwidth constraint relating to the communication path or does not fit within available memory of the mobile unit, then:

[0019] restructuring, by the home computer unit, the extracted requested information into downsized information such that the downsized information satisfies the bandwidth constraint and fits within the available memory of the mobile unit, and

[0020] transmitting, by the home computer unit, the downsized information to the mobile unit over the communication path.

[0021] The present invention provides a multimedia dictionary having reference content entries which are mapped into compact content entries,

[0022] wherein the multimedia dictionary is coupled to a home computer unit,

[0023] wherein the home computer unit is adapted to engage in two-way communication with a mobile unit over a communication path,

[0024] wherein a portion of the communication path is wireless,

[0025] wherein the home computer unit is adapted to receive at least one signal sent by the mobile unit to the home computer unit over the communication path,

[0026] wherein the at least one signal comprises a request by the mobile unit for information from the home computer unit,

[0027] wherein the home computer unit is adapted to extract the requested information from a data source,

[0028] wherein if the extracted requested information does not satisfy a bandwidth constraint relating to the communication path or does not fit within available memory of the mobile unit, then the home computer unit is adapted to effectuate a restructuring of the extracted requested information into downsized information such that the downsized information satisfies the bandwidth constraint and fits within the available memory of the mobile unit, and

[0029] wherein the home computer unit is adapted to transmit the downsized information to the mobile unit over the communication path,

[0030] wherein the home computer unit is adapted to determine a modality of the downsized information by use of the multimedia dictionary,

[0031] wherein the extracted requested information relates to a first reference content entry of the reference content entries of the multimedia dictionary, and

[0032] wherein the downsized information relates a first compact content entry of the compact content entries of the multimedia dictionary such that the first reference content entry is mapped into the first compact content entry.

[0033] The present invention provides a system and method for communicating data between disparate computer systems in such a way that such data communication is efficient, accurate, and not too slow.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] **FIG. 1** is a block diagram of a system for communicating between a home computer unit and a mobile unit, in accordance with embodiments of the present invention.

[0035] **FIG. 2** depicts the home computer unit of **FIG. 1** exchanging signals with the mobile unit of **FIG. 1**, in accordance with embodiments of the present invention.

[0036] **FIG. 3** depicts extracted information being restructured by the home computer unit of **FIG. 1** into downsized information, wherein the extracted information had been previously requested by the mobile unit of **FIG. 1**, in accordance with embodiments of the present invention.

[0037] **FIG. 4A** depicts a intra-modality restructuring of a visual modality, in accordance with embodiments of the present invention.

[0038] **FIG. 4B** depicts a intra-modality restructuring of a audio modality, in accordance with embodiments of the present invention.

[0039] **FIG. 4C** depicts a intra-modality restructuring of a text modality, in accordance with embodiments of the present invention.

[0040] **FIG. 5A** depicts a cross-modality restructuring of a visual modality to a text modality, in accordance with embodiments of the present invention.

[0041] **FIG. 5B** depicts a cross-modality restructuring of an audio modality to a text modality, in accordance with embodiments of the present invention.

[0042] **FIG. 6** depicts, in a perspective view, the result of an intra-modality restructuring of a visual modality into a layered mosaic structure, in accordance with embodiments of the present invention.

[0043] **FIG. 7A** illustrates a region having variations in color as expressed in shades of grey.

[0044] **FIG. 7B** depicts the region of **FIG. 7A** after being restructured by being smoothed with respect to its variations in shades of grey, in accordance with embodiments of the present invention.

[0045] **FIG. 8A** illustrates a region having variations in texture.

[0046] **FIG. 8B** depicts the region of **FIG. 8A** after being restructured by being smoothed with respect to its variations in texture, in accordance with embodiments of the present invention.

[0047] **FIG. 9** illustrates a television icon, in accordance with embodiments of the present invention.

[0048] **FIG. 10** illustrates the functionality of a multimedia dictionary, in accordance with embodiments of the present invention.

[0049] **FIG. 11** is a flow chart showing a first method of determining which downsized information to generate by restructuring, in accordance with embodiments of the present invention.

[0050] **FIG. 12** is a flow chart showing a second method of determining which downsized information to generate by restructuring, in accordance with embodiments of the present invention.

[0051] **FIG. 13** is a flow chart showing a third method of determining which downsized information to generate by restructuring, in accordance with embodiments of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0052] **FIG. 1** is a block diagram of a system **10** for communicating between a home computer unit **12** and a mobile unit **14** over a communication path **20**, in accordance with embodiments of the present invention. The home computer unit **12** comprises any computer or computer system that is fixed and not mobile such as, inter alia, a personal computer, a work station, a mainframe computer, etc. The home computer unit **12** may be positioned in any fixed location such as in, inter alia, a home, an office, etc. The home computer unit **12** is capable of engaging in data processing functions such as, inter alia: computing; storing and retrieving data from a peripheral source; transmitting and receiving data over a network, data path (e.g., the communication path **20**), etc. The home computer unit **12** has sufficient computation power for performing "hard" computations on large files such, inter alia, graphics files. If located in a residence, the home computer unit **12** may be capable of performing such tasks as control of ambient temperature, playing of radio, playing of television, turning on or off electric circuits, etc. The home computer unit **12** has hardware that is typically found in computers and computer systems such as memory (e.g., dynamic random access memory, read-only memory, hard disk, optical disk,

floppy disk, etc.), input devices (e.g., keyboard, mouse, computer screen, etc.), output devices (e.g., printer, plotter, computer screen, magnetic tape, removable hard disk, floppy disk, etc.), and a processor for executing software, performing computations, controlling the input and output devices, etc.

[0053] The mobile unit **14** comprises any mobile device that is capable of being easily moved. The mobile unit **14** may be hand-held and may be small enough to be inserted in a handbag, pocket, etc. Although the mobile unit **14** is capable of performing computation, logic (e.g., making decisions) and storing of data, the mobile unit **14** has limited computing and data storage capabilities and is thus incapable of doing highly intensive calculations with large graphics files. Additionally, the mobile unit **14** may have limited or no access to external databases, but may have limited access to the Internet. Examples of the mobile unit **14** include, inter alia: cellular phone with display screen, PDA/cell phone (note: PDA stands for personal digital assistant), etc.

[0054] The communication path **20** includes a wireless portion **22** and may also include a wired portion **21**. The wireless portion **22** of the communication path **20**, which is directly coupled to the mobile unit **14**, exists in all embodiments of the present invention. The wired portion **21** of the communication path **20** exist in some, but not all, embodiments of the present invention. For embodiments in which the wired portion **21** is not present, the mobile unit **14** may be analogous to a cellular phone receiving a signal from the home computer unit **12** over the communication path **20** that is totally wireless, but which may require intermediate relay stations between the home computer unit **12** and the mobile unit **14**. For embodiments in which the wired portion **21** is present, the mobile unit **14** may be analogous to a wireless phone such that the wired portion **21** may be telephone wire originating at the home computer unit **12** and ending at a base device at the user's residence, wherein the base device has a transmitter that transmits a signal to the mobile unit **14** wireless phone over the wireless portion **22** that is located within a small radius from the base. The wired portion may comprise any wiring used for communicating data such as, inter alia, telephone wiring, cable wiring, etc. If the wired portion **21** exists, then the wireless portion **22** may be less than the wired portion **21** (i.e., the wireless portion **22** is shorter in linear length than is the wired portion **21**). Alternatively if the wired portion **21** exists, then the wireless portion **22** may be equal to or greater than the wired portion **21**.

[0055] The communication path **20** is a two-way communication path, as illustrated in **FIG. 2**. **FIG. 2** depicts the home computer unit **12** of **FIG. 1** exchanging signals with the mobile unit **14** of **FIG. 1**, in accordance with embodiments of the present invention. Thus, the home computer unit **12** may transmit a signal **26** to the mobile unit **14** via the communication path **20** (see **FIG. 1**), and the mobile unit **14** may transmit a signal **28** to the home computer unit **12** via the communication path **20**.

[0056] Without the home computer unit **12**, the mobile unit **14** would have little or no more functionality than an intelligent phone/organizer. Accordingly, the mobile unit **14** is dependent on the home computer unit **12** for receiving information, via the communication path **20**, that the home computer unit **12** has access to. As shown in **FIG. 1**, the home computer unit **12** is coupled to, and thus has access to, inter alia, a database **16**, the Internet **18**, a source of video data **19**, and a multimedia dictionary **24** which will be discussed infra in conjunction with **FIG. 10**. At any instant of time, the mobile unit **14** may send a request for information to the home computer unit **12**, said request for information being sent over the communication path **20**. Due to the limited storage capacity (e.g., memory) of the mobile unit **14** and bandwidth constraints relating to the communication path **20**, the home computer unit **12** may not be able to satisfy the request as formulated by the mobile unit **14**. If the home computer unit **12** does not have knowledge of the available storage capacity of the mobile unit **14** and the bandwidth constraints relating to the communication path **20**, then the two-way communication between the home computer unit **12** and the mobile unit **14** may be beneficially exploited. For example, the home computer unit **12** may send a query signal (see, e.g., the signal **26** of **FIG. 2**) to the mobile unit **14** over the communication path **20**, wherein the query signal requests information as to the available storage capacity of the mobile unit **14** and/or bandwidth constraints relating to the communication path **20**. The mobile unit **14** may answer the query by transmitting an answer to the home computer unit **12** via the signal **28** (see **FIG. 2**). Said answer so transmitted by the mobile unit **14** includes a specification of the available memory of the unit **14** and/or bandwidth constraints relating to the communication path **20**. Such communication of metadata between the home computer unit **12** and the mobile unit **14** is ancillary to the actual information that had been requested by the mobile unit **14**.

[0057] The bandwidth constraints relating to the communication path **20** may take into account the bandwidth (B) of the communication path **20** as expressed in terms of the maximum number of bits per second that can be transported in the communication path **20**. If the information requested by the mobile unit **14** encompasses a total size of S bits, then the transport time via the communication path **20** of said information from the home computer unit **12** to the mobile unit **14** is S/B seconds. The bandwidth constraints relating to the communication path **20** may be expressed as any relevant function of B and S/B. For example, the bandwidth constraint may be $S/B<60$ seconds. As another example, the bandwidth constraint may be a real-time bandwidth constraint such as when the requested information is a real-time feed such as a real-time video feed or a real-time telecast (e.g., a sports event). With a real-time feed of F bits per second of data, the real-time bandwidth constraint may be $B \geqq F$.

[0058] With the present invention, the home computer unit **12** receives a request for information from the mobile unit **14**, and the home computer unit **12** is informed as to the available storage capacity of the mobile unit **14** and bandwidth constraints relating to the communication path **20** as discussed supra. The home computer unit **12** may extract the requested information from a data source. Examples of applicable data sources comprise the database **16**, the Internet **17**, and the source of video data **18** (e.g., frames of video data or a feed of frames of video data). If the requested information, as extracted by the home computer unit **12**, does not satisfy a bandwidth constraint relating to the communication path **20** or does not fit within available memory of the mobile unit **14**, then in accordance with the

present invention, the home computer unit **12** restructures the extracted requested information into downsized information such that the downsized information satisfies the bandwidth constraint and fits within the available memory of the mobile unit **14**. After said "content restructuring"(called "restructuring" for short), the home computer unit **12** transmits the downsized information to the mobile unit **14** over the communication path **20**.

[**0059**] **FIG. 3** shows that the downsized information **32**, as restructured **31** from the extracted requested information **30**, is "smaller" in bit-size than the extracted requested information **30** (i.e., encompasses fewer bits than the extracted requested information **30**) in order to satisfy the bandwidth constraint(s) and fit within the available memory of the mobile unit **14**. Logistically, the extracted requested information **30** does not have to be literally "extracted" in its entirety from the data source but may be partially extracted or not extracted at all if the downsized information **32** could be generated without operating directly on the requested data in the data source, such as by use of the multimedia dictionary **24** of **FIG. 1** as will be discussed infra in conjunction with **FIG. 10**. For example, if the requested information **30** comprises a visual image of the White House in Washington and if the multimedia dictionary **24** receives input indicating that the requested information **30** comprises the White House in Washington (e.g., from the words "White House", from an icon that identifies the White House in Washington, etc.), and if the multimedia dictionary **24** includes information that identifies the White House in Washington and also includes associated text that describes the White House in Washington, then the downsized information **32** could be generated to include such text without the necessity of actually extracting a visual image of the White House in Washington.

[**0060**] If the bandwidth constraint is a real-time bandwidth constraint, then some or all of the restructuring algorithms may be embedded in hardware (e.g., a Fast Fourier Transform algorithm in a semiconductor chip) instead of being implemented in software, in order to minimize the processing time for the restructuring.

[**0061**] The restructuring of the requested information **30** into the downsized information **32** depends on the modality of the requested information **30**. The "modality" denotes a medium of expression such as a visual modality, an audio modality, and a text modality. The visual modality includes, inter alia, a video modality (e.g., a feed or stream of video frames) and a graphics modality (i.e., synthetic imagery such as any synthetic graphics representation of information such as a graph, a pictorial bit pattern, etc.). The audio modality denotes an expression of information in terms of sound such as, inter alia, speech, music, etc. The text modality denotes an expression of information in terms of written language (e.g., words, sentences, etc.).

[**0062**] The restructuring of the requested information **30** into the downsized information **32** is such that the requested information **30** is expressed in modality A and the downsized information **32** is expressed in modality B. A restructuring such that modality A is equal to modality B is called an intra-modality restructuring. **FIG. 4A** depicts an intra-modality restructuring from the visual modality to the visual modality, **FIG. 4B** depicts an intra-modality restructuring from the audio modality to the audio modality, and **FIG. 4C** depicts an intra-modality restructuring from the text modality to the text modality. A restructuring such that modality A differs from modality B is called a cross-modality restructuring. **FIG. 5A** depicts an cross-modality restructuring from the visual modality to the text modality, and **FIG. 5B** depicts an cross-modality restructuring from the audio modality to the text modality.

[**0063**] As an example of a request for information and consequent restructuring, a real estate agent who has access to the mobile unit **14** wants to show a client buyer a video of a house that the buyer is interested in. Due to bandwidth constraints relating to the communication path **20** or lack of sufficient available memory at the mobile unit **14**, the real estate agent cannot obtain a visual representation of the house from the home computer unit **12**. Instead, the home computer unit **12** sends a restructured downsized version of the requested video (e.g., an equivalent textual representation of visual information relating to the house) to the real estate agent at the mobile unit **14**. As another example of a request for information and consequent restructuring, an emergency-room doctor at the mobile unit **14** must operate on a patient in 2 minutes, but the patient data is in the database of another hospital. Due to bandwidth constraints relating to the communication path **20** or lack of sufficient available memory at the mobile unit **14**, the doctor may not get the X-ray from the home computer unit **12** at the another hospital but instead will get restructured downsized information in the form of a text description of the X-ray. Note that a given mobile unit **14** may be used for different purposes at different times such as being used for real estate purposes during daytime hours and for personal purposes (e.g., shopping) during evening hours.

[**0064**] The intra-modality restructuring of a visual modality into the downsized information shown in **FIG. 4A** may include various techniques including, inter alia, generation of layered mosaics, cartoonification, and iconification.

[**0065**] Layered mosaics are planar images extended in a direction that is normal to the planar images. The layered mosaics encode limited information about a pictorial representation (e.g., a sequence of video frames). The mosaics are accumulated in layers according to the associated relative depth of regions within the pictorial representation. The layer depths simulate objects at different depth levels. Generally an object appearing in multiple successive video frames may be represented as a mosaic layer provided that the object does not change in time or changes insignificantly in time over the video frame subset represented by the mosaic layer. This enables many frames (e.g, 300 frames) to be represented as a single mosaic layer, which enables the restructuring to highly reduce the amount of data to be transported over the communication path **20** as compared with the original sequence of frames.

[**0066**] For illustrative purposes, **FIG. 6** depicts, in a perspective view, the result of an intra-modality restructuring of a visual modality (e.g., of a visual image or a portion thereof) into a layered mosaic structure **40**, in accordance with embodiments of the present invention. The mosaic structure **40** comprises mosaic layers **41-45** as shown. Each such mosaic layer in **FIG. 6** comprises a discrete object that does not change in time or changes insignificantly in time over the video frame subset represented by the mosaic layer. For example, a front face **46** of the mosaic layer **41** comprises a tree **48** as shown. Although hidden in the perspective view of **FIG. 6**, each of the other mosaic layers **42-45** comprise one or more discrete object (e.g., a house, a flower bed, etc.) that does not change in time or changes insignificantly in time over the video frame subset represented by the mosaic layer. The representation of numerous video frames

in a single mosaic layer facilitates a significant reduction of data in the intra-modality restructuring of the video modality into the downsized information represented by the layered mosaic structure **40**.

[**0067**] The mosaics layers are generated incrementally through recursive algorithms. At each step of these recursive algorithms, comparing the mosaic layer generated at the previous instance with the current image of the video sequence generates a new instance of this mosaic.

[**0068**] Cartoonification denotes a process in which complex features of a natural image, or a portion of the natural image, are simplified, such as by smoothing of motion (e.g., motion as depicted in successive frames of a dynamic video feed) or smoothing of spatial regions. Smoothing of motion restructures the motion to be represented more simply such as being less diverse and more uniform. Smoothing of spatial regions comprises such smoothing techniques as, inter alia, smoothing of color, smoothing of brightness, and smoothing of texture.

[**0069**] **FIG. 7A** depicts a region **50** of a visual image, wherein the region **50** has variations in color as expressed in terms of variation in shades of grey, said region **50** comprising region segments **51-53**, each said region segment having a uniform color (i.e., a uniform shade of grey). **FIG. 7B** depicts the region **50** of **FIG. 7A** after being restructured into region **55** by being smoothed with respect to its variations in color (i.e., variation in shade of grey) so as to acquire a uniform shade of grey throughout the region **55**, in accordance with embodiments of the present invention. The smoothing of color or shades of grey facilitates a reduction in the number of bits needed to represent the region **50**, so that fewer bits are needed to represent the downsized information of the smoothed region **55**. Similarly, smoothing over variations of brightness in a specified region of a visual image, or of a portion of the natural image, facilitates a reduction in the number of bits needed to represent the downsized region that has been restructured from the specified region.

[**0070**] **FIG. 8A** depicts a region **60** of a natural image, wherein the region **60** has variations in texture. The texture in the region **60** is expressed by the box pattern defined by horizontal lines **61-67** and vertical lines **71-77**. **FIG. 8B** depicts the region **60** of **FIG. 8A** after being restructured into region **62** by being smoothed with respect to its variations in texture, in accordance with embodiments of the present invention. The smoothing comprises removing horizontal lines **62**, **64**, **66** and vertical lines **72**, **74**, **76** so that the resulting box pattern of region **62** is coarser than the box pattern of region **60**. Accordingly, the smoothing of texture facilitates a reduction in the number of bits needed to represent the region **60**, so that fewer bits are needed to represent the downsized information of the smoothed region **62**.

[**0071**] Iconification denotes a process in which a symbol or a symbolic image (e.g., a graphic symbol), called an "icon," represents an object, entity, item, etc. The icon can be any symbolic representation that the user would recognize as representing the object, entity, item, etc (e.g., a stick figure icon representing a person). As an illustrated example, **FIG. 9** depicts a television icon **70**, in accordance with embodiments of the present invention. The television icon **70** represents a natural image of a television. The television icon **70** requires fewer bits to be described than does the natural image of the television that the television icon **70** represents. Accordingly, the iconification facilitates a reduction in the number of bits needed to represent the object, entity, item, etc (e.g., the television), so that fewer bits are needed to represent the downsized information (i.e., the icon such as, for example, the television icon **70**).

[**0072**] The intra-modality restructuring of an audio modality into the downsized information shown in **FIG. 4B** may eliminate redundant audio data and may include various techniques including, inter alia: a representation of natural sound by synthetic sound, or any other technique known to a person of ordinary skill in the art.

[**0073**] The intra-modality restructuring of a text modality into the downsized information shown in **FIG. 4C** may include various techniques including: inter alia, summarization, natural language processing to take a first text and generate a second text that is an interpretation of the first text, etc. Any method of compactly representing text, as is known to a person of ordinary skill in the art, is encompassed by the present invention.

[**0074**] The cross-modality restructuring of a visual modality into the downsized information of a text modality, as shown in **FIG. 5A**, represents pictorial information as text. For example, a visual image of a lady looking at her baby may be restructured to the text: "Lady looking at her baby." Such restructuring from visual modality to text modality may be implemented in software having a text-based database available to the software. Such software may recognize pictorial information and replace such pictorial information by text that has been stored in the database. For example, a movie of Manhattan from New Jersey may be generated, in part, by panning and the software may recognize some buildings in the movie (e.g., the Chrysler building, the Empire State building, etc.). Having recognized the buildings, the software may replace the pictorial representations of the buildings by such words as "Chrysler building", "Empire State building", etc. The text description for cross-modality restructuring of a visual modality to a text could be as limited as desired so as long as the text description is meaningful. Additionally, portions of the pictorial image (as opposed to the whole pictorial image) can be isolated and described by text.

[**0075**] The cross-modality restructuring of an audio modality into the downsized information of a text modality, as shown in **FIG. 5B**, represents audio information as text. For example, closed caption text, also called "speech-to-text," is commonly known in the art (e.g., in speech recognition software"). Said cross-modality restructuring of an audio modality into the text modality significantly reduces bits, since audio files generally require many more data bits to be represented than do analogous text files.

[**0076**] A hybrid restructuring involving both intra-modality restructuring and cross-modality restructuring is within the scope of the present invention. For example, a layered mosaic can be annotated with a text description, a cartoon can be also be annotated with a text description, etc. Such annotated textual descriptions, if short, would not add a significant number of bits to the layered mosaic, cartoon, etc.

[**0077**] **FIG. 10** illustrates the functionality of a multimedia dictionary **80**, which is analogous to the multimedia dictionary **24** of **FIG. 1**, in accordance with embodiments of the present invention. The multimedia dictionary **80** can be used to translate content information from one modality to another or within a given modality. The multimedia dictionary **80** has synonyms, acronyms, etc. The multimedia dictionary **80** describes how to restructure from one modal-

ity to another. Thus in the multimedia dictionary **80** of **FIG. 10**, content information in modality A is mapped (i.e., restructured) into modality B within or across modalities. The multimedia dictionary **80** may store input images and describes restructured output associated with the stored input images. Each content object in the multimedia dictionary **80** is given a description that is textual or is based on metadata information. The metadata information can be generated in a proprietary form, or it can be based on common agreed-upon standards (e.g., MPEG-7, TV-Anytime, and/or SIMPTE). The restructuring between elements of different modalities should be done using the descriptions in the multimedia dictionary **80**. The restructurings could get into the multimedia dictionary **80** either by recording restructurings as they occur in practice or by pre-planning certain standard restructurings and placing those standard restructurings in the multimedia dictionary **80**. Thus, the multimedia dictionary **80** could be used to standardize certain restructurings so that a subsequent table lookup would effectuate a designated restructuring instead of executing a complex algorithm.

[**0078**] In order to effectuate restructuring, the present invention determines which downsized information to generate by the restructuring by any reasonable method such as by, inter alia, the following first method, second method, or third method.

[**0079**] The first method of determining which downsized information to generate by the restructuring is shown in the flow chart of **FIG. 11**. In **FIG. 11**, the home computer unit **12** ascertains N permissible downsized information possibilities $M_1, M_2, \ldots$, and M_N, wherein $N \geqq 1$. If N=1 then the home computer unit **12** determines that M_1 is the downsized information to generate by the restructuring. If N>1, however, then the home computer unit **12** sends a query signal to the mobile unit **14** over the communication path **20**. The query signal comprises a request of a selection by the mobile unit **14** of a preferred downsized information M_k (k=1, 2, . . . , or N) from $M_1, M_2, \ldots$, and M_N such that M_k will be generated by the restructuring. The home computer unit **12** receives a query return signal from the mobile unit **14** over the communication path **20**. The query return signal specifies M_k.

[**0080**] The second method of determining which downsized information to generate by the restructuring is shown in the flow chart of **FIG. 12**. In **FIG. 12**, the home computer unit **12** ascertains N permissible downsized information possibilities $M_1, M_2, \ldots$, and M_N respectively having a size in bits of $B_1, B_2, \ldots$, and B_N wherein $N \geqq 1$. If N=1 then the home computer unit **12** determines that M_1 is the downsized information to generate by the restructuring. If N>1, however, then the home computer unit **12** selects M_k as the downsized information to generate by the restructuring, wherein k is one of 1, 2, . . . , and N such that B_k is a minimum of $B_1, B_2, \ldots$, and B_N.

[**0081**] The third method of determining which downsized information to generate by the restructuring is shown in the flow chart of **FIG. 13**. In **FIG. 13**, the home computer unit **12** ascertains N permissible downsized information possibilities $M_1, M_2, \ldots$, and M_N respectively having a size in bits of $B_1, B_2, \ldots$, and B_N, wherein $N \geqq 1$. If N=1 then the home computer unit **12** determines that M_1 is the downsized information to generate by the restructuring. If N>1, however, then the home computer unit **12** selects M_k as the downsized information to generate by the restructuring, wherein k is one of 1, 2, . . . , and N such that B_k is a maximum of $B_1, B_2, \ldots$, and B_N.

[**0082**] While embodiments of the present invention have been described herein for purposes of illustration, many modifications and changes will become apparent to those skilled in the art. Accordingly, the appended claims are intended to encompass all such modifications and changes as fall within the true spirit and scope of this invention.

What is claimed is:

1. A system for communication and processing of data, comprising a home computer unit and a mobile unit,

wherein the home computer unit is adapted to engage in two-way communication with the mobile unit over a communication path,

wherein a portion of the communication path is wireless,

wherein the home computer unit is adapted to receive at least one signal sent by the mobile unit to the home computer unit over the communication path,

wherein the at least one signal comprises a request by the mobile unit for information from the home computer unit,

wherein the home computer unit is adapted to extract the requested information from a data source, and

wherein if the extracted requested information does not satisfy a bandwidth constraint relating to the communication path or does not fit within available memory of the mobile unit, then:

the home computer unit is adapted to effectuate a restructuring of the extracted requested information into downsized information such that the downsized information satisfies the bandwidth constraint and fits within the available memory of the mobile unit, and

the home computer unit is adapted to transmit the downsized information to the mobile unit over the communication path.

2. The system of claim 1, wherein the portion of the communication path that is wireless includes the entire communication path.

3. The system of claim 1, wherein the portion of the communication path that is wireless is shorter than a portion of the communication path that is not wireless.

4. The system of claim 1, wherein the bandwidth constraint comprises a real-time bandwidth constraint.

5. The system of claim 1, wherein the at least one signal comprises a specification of the bandwidth constraint.

6. The system of claim 1, wherein the at least one signal comprises a specification of the available memory of the mobile unit.

7. The system of claim 1, wherein the data source comprises at least one database external to the home computer unit.

8. The system of claim 1, wherein the data source comprises an Internet.

9. The system of claim 1, wherein the data source comprises a source of video data.

10. The system of claim 1, wherein the restructuring comprises an intra-modality restructuring of a modality of the requested information.

11. The system of claim 10, wherein the modality comprises a visual modality that includes a video modality.

12. The system of claim 10, wherein the modality comprises a visual modality that includes a graphics modality.

13. The system of claim 10 wherein the modality includes a visual modality, wherein the visual modality includes an image, and wherein the intra-modality restructuring includes generation of layered mosaics from a portion of the image.

14. The system of claim 10, wherein the modality comprises a visual modality, wherein the visual modality includes an image, and wherein the intra-modality restructuring includes cartoonification of a portion of the image.

15. The system of claim 14, wherein the cartoonification comprises a smoothing of an attribute of the portion of the image, and wherein the attribute is at least one of color, brightness, and texture.

16. The system of claim 10, wherein the modality comprises a visual modality, wherein the visual modality includes an image, and wherein the intra-modality restructuring includes iconification of a portion of the image.

17. The system of claim 10, wherein the modality includes an audio modality.

18. The system of claim 10, wherein the modality includes a text modality

19. The system of claim 1, wherein the restructuring comprises a cross-modality restructuring of a first modality into a second modality.

20. The system of claim 19, wherein the first modality comprises a visual modality, and wherein the second modality comprises a text modality.

21. The system of claim 20, wherein the visual modality includes a video modality.

22. The system of claim 20, wherein the visual modality includes a graphics modality.

23. The system of claim 1, wherein the home computer unit is adapted to determine a modality of the downsized information by use of a multimedia dictionary having a reference content entry that is mapped into a compact content entry, wherein the extracted requested information relates to the reference content entry, and wherein the downsized information relates to the compact content entry.

24. A method for communicating and processing data, comprising

providing a home computer unit;

engaging, by the home computer unit, in two-way communication with a mobile unit over a communication path, wherein a portion of the communication path is wireless;

receiving, by the home computer unit, at least one signal sent by the mobile unit to the home computer unit over the communication path such that the at least one signal comprises a request by the mobile unit for information from the home computer unit;

extracting, by the home computer unit, the requested information from a data source, wherein if the extracted requested information does not satisfy a bandwidth constraint relating to the communication path or does not fit within available memory of the mobile unit, then:

restructuring, by the home computer unit, the extracted requested information into downsized information such that the downsized information satisfies the bandwidth constraint and fits within the available memory of the mobile unit, and

transmitting, by the home computer unit, the downsized information to the mobile unit over the communication path.

25. The system of claim 24, wherein the portion of the communication path that is wireless includes the entire communication path.

26. The system of claim 24, wherein the portion of the communication path that is wireless is shorter than a portion of the communication path that is not wireless.

27. The method of claim 24, wherein the bandwidth constraint comprises a real-time bandwidth constraint.

28. The method of claim 24, wherein the at least one signal comprises a specification of the bandwidth constraint.

29. The method of claim 24, wherein the at least one signal comprises a specification of the available memory of the mobile unit.

30. The method of claim 24, wherein the data source comprises at least one database external to the home computer unit.

31. The method of claim 24, wherein the data source comprises an Internet.

32. The method of claim 24, wherein the data source comprises a source of video data.

33. The method of claim 24, wherein the restructuring comprises an intra-modality restructuring of a modality of the requested information.

34. The method of claim 33, wherein the modality comprises a visual modality that includes a video modality.

35. The method of claim 33, wherein the modality comprises a visual modality that includes a graphics modality.

36. The method of claim 33, wherein the modality includes a visual modality, wherein the visual modality includes an image, and wherein the intra-modality restructuring includes generation of layered mosaics from a portion of the image.

37. The method of claim 33, wherein the modality comprises a visual modality, wherein the visual modality includes an image, and wherein the intra-modality restructuring includes cartoonification of a portion of the image.

38. The method of claim 37, wherein the cartoonification comprises a smoothing of an attribute of the portion of the image, and wherein the attribute is at least one of color, brightness, and texture.

39. The method of claim 33, wherein the modality comprises a visual modality, wherein the visual modality includes an image, and wherein the intra-modality restructuring includes iconification of a portion of the image.

40. The method of claim 33, wherein the modality includes an audio modality.

41. The method of claim 33, wherein the modality includes a text modality

42. The method of claim 24, wherein the restructuring comprises a cross-modality restructuring of a first modality into a second modality.

43. The method of claim 42, wherein the first modality comprises a visual modality, and wherein the second modality comprises a text modality.

44. The method of claim 43, wherein the visual modality includes a video modality.

45. The method of claim 43, wherein the visual modality includes a graphics modality.

46. The method of claim 24, wherein the restructuring comprises utilizing a multimedia dictionary having a reference content entry that is mapped into a compact content entry, wherein the extracted requested information relates to the reference content entry, and wherein the downsized information relates to the compact content entry.

47. The method of claim 24, wherein the restructuring comprises determining which downsized information to generate by the restructuring, said determining comprising:

ascertaining, by the home computer unit, N permissible downsized information possibilities, wherein N is at least 1;

if N=1 then determining that the ascertained permissible downsized information possibility is the downsized information to generate by the restructuring;

if N>1 then

sending a query signal by the home computer unit to the mobile unit over the communication path, wherein the query signal comprises a request of a selection by the mobile unit of a preferred downsized information from the N permissible downsized information possibilities such that the preferred downsized information will be generated by the restructuring, and

receiving by the home computer unit a query return signal from the mobile unit over the communication path, wherein the query return signal specifies the preferred downsized information.

48. The system of claim 24, wherein the restructuring comprises determining which downsized information to generate by the restructuring, said determining comprising:

ascertaining, by the home computer unit, N permissible downsized information possibilities M_1, M_2, . . . , and M_N respectively having a size in bits of B_1, B_2, . . . , and B_N, wherein $N \geqq 1$;

if N=1 then determining that M_1 is the downsized information to generate by the restructuring;

if N>1 then selecting M_k as the downsized information to generate by the restructuring, wherein k is one of 1, 2, . . . , and N such that B_k is a minimum of B_1, B_2, . . . , and B_N.

49. The system of claim 24, wherein the restructuring comprises determining which downsized information to generate by the restructuring, said determining comprising:

ascertaining, by the home computer unit, N permissible downsized information possibilities M_1, M_2, . . . , and M_N respectively having a size in bits of B_1, B_2, . . . , and B_N, wherein $N \geqq 1$;

if N=1 then determining that M_1 is the downsized information to generate by the restructuring;

if N>1 then selecting M_k as the downsized information to generate by the restructuring, wherein k is one of 1, 2 , . . . , and N such that B_k is a maximum of B_1, B_2, . . . , and B_N.

50. A multimedia dictionary having reference content entries which are mapped into compact content entries,

wherein the multimedia dictionary is coupled to a home computer unit,

wherein the home computer unit is adapted to engage in two-way communication with a mobile unit over a communication path,

wherein a portion of the communication path is wireless,

wherein the home computer unit is adapted to receive at least one signal sent by the mobile unit to the home computer unit over the communication path,

wherein the at least one signal comprises a request by the mobile unit for information from the home computer unit,

wherein the home computer unit is adapted to extract the requested information from a data source,

wherein if the extracted requested information does not satisfy a bandwidth constraint relating to the communication path or does not fit within available memory of the mobile unit, then the home computer unit is adapted to effectuate a restructuring of the extracted requested information into downsized information such that the downsized information satisfies the bandwidth constraint and fits within the available memory of the mobile unit, and

wherein the home computer unit is adapted to transmit the downsized information to the mobile unit over the communication path,

wherein the home computer unit is adapted to determine a modality of the downsized information by use of the multimedia dictionary,

wherein the extracted requested information relates to a first reference content entry of the reference content entries of the multimedia dictionary, and

wherein the downsized information relates a first compact content entry of the compact content entries of the multimedia dictionary such that the first reference content entry is mapped into the first compact content entry.

51. A system for communication and processing of data, comprising a home computer unit,

wherein the home computer unit is adapted to engage in two-way communication with a mobile unit over a communication path,

wherein a portion of the communication path is wireless,

wherein the home computer unit is adapted to receive at least one signal sent by the mobile unit to the home computer unit over the communication path,

wherein the at least one signal comprises a request by the mobile unit for information from the home computer unit,

wherein the home computer unit is adapted to extract the requested information from a data source, and

wherein if the extracted requested information does not satisfy a bandwidth constraint relating to the communication path or does not fit within available memory of the mobile unit, then:

the home computer unit is adapted to effectuate a restructuring of the extracted requested information into downsized information such that the downsized information satisfies the bandwidth constraint and fits within the available memory of the mobile unit, and

the home computer unit is adapted to transmit the downsized information to the mobile unit over the communication path.

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