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(54) DEVICE PAIRING BASED ON GRAPHICALLY ENCODED DATA

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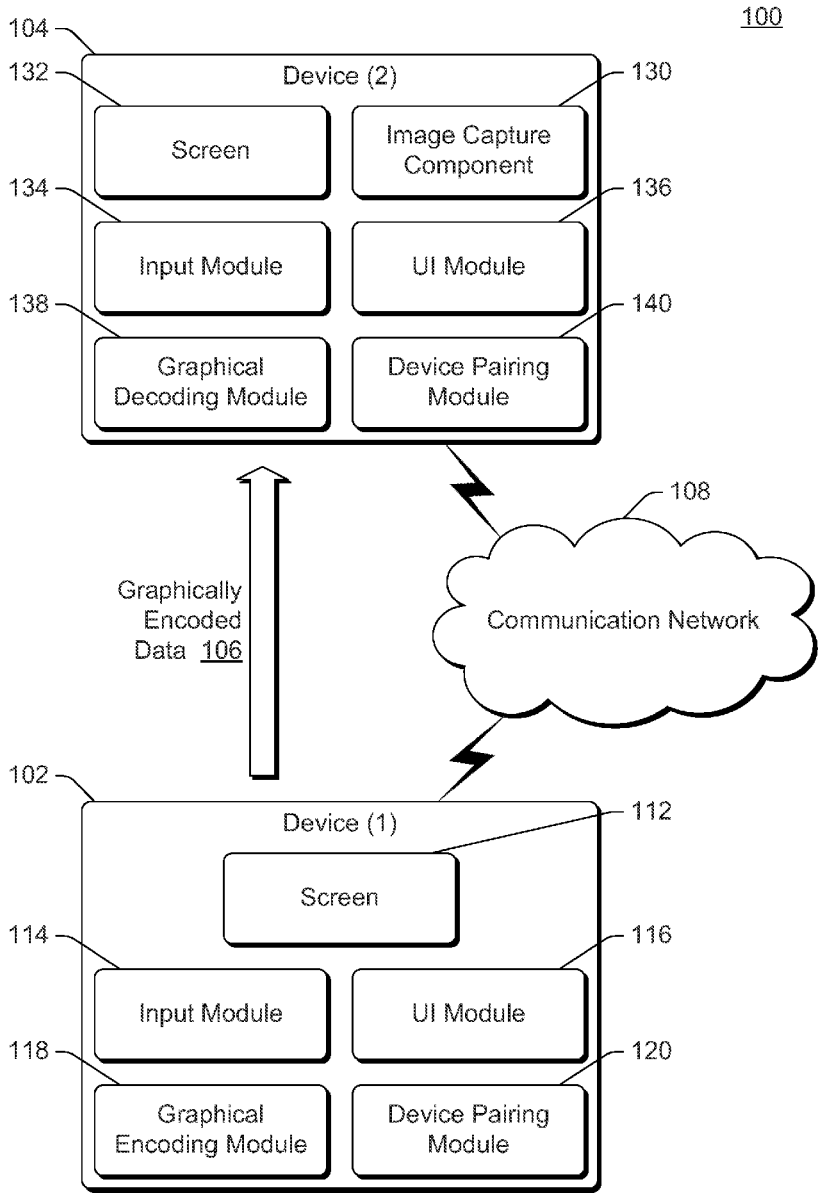
(57) **ABSTRACT**

In a computing device, both an address of a first device and a secret are graphically encoded to generate one or more images that can be captured by a second device. The second device captures and decodes the one or more images, and sends a communication initiation request to the address of the first device. The communication initiation request includes the address of the second device and identifies the secret. Communication between the first and second device continues only if the first device verifies, based on the communication initiation request, that the second device knows the secret.



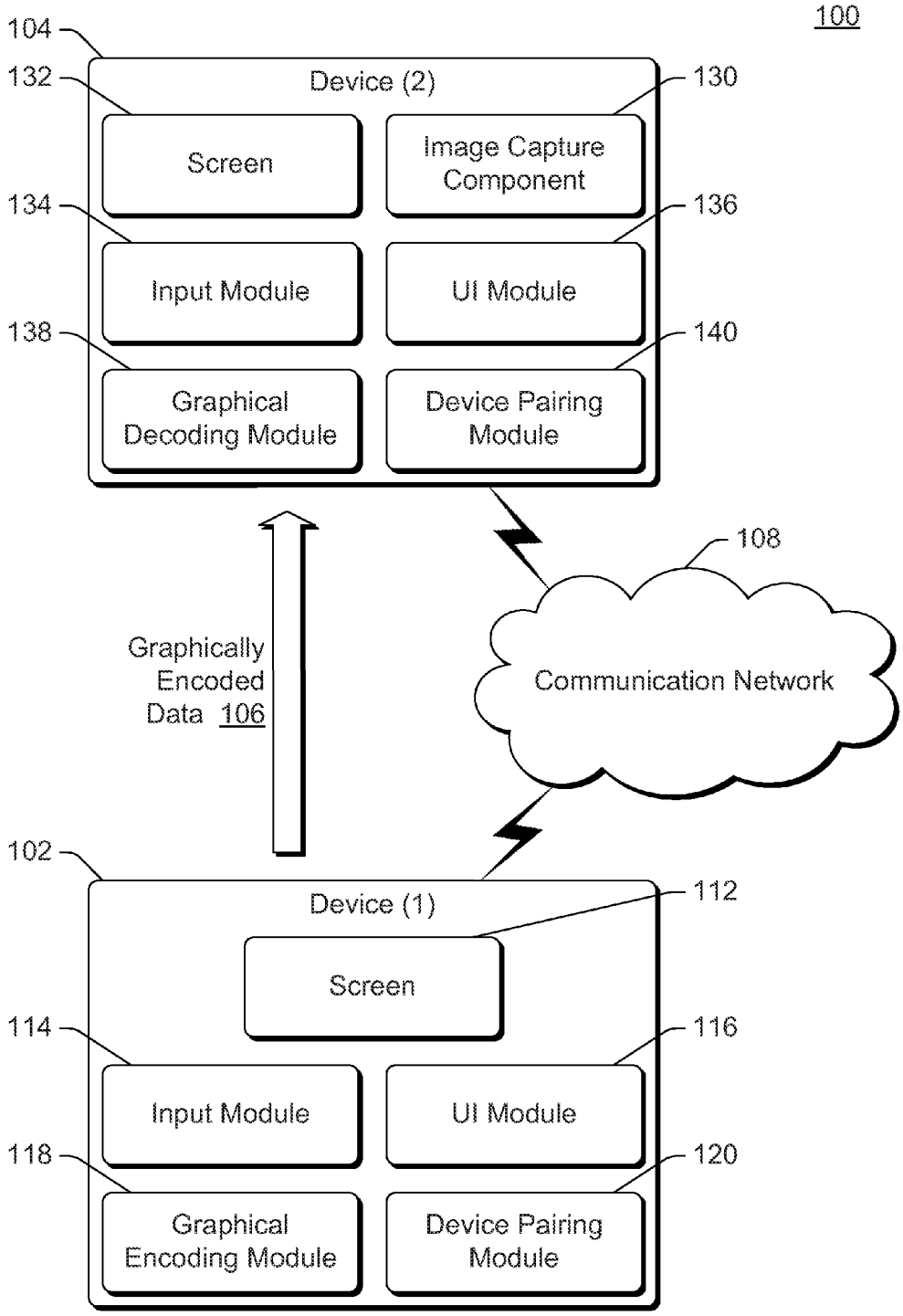

100
104
Device (2)
132
130
Screen
Image Capture Component
134
136
Input Module
UI Module
138
140
Graphical Decoding Module
Device Pairing Module
108
Communication Network
Graphically Encoded Data 106
102
Device (1)
112
Screen
114
116
Input Module
UI Module
118
120
Graphical Encoding Module
Device Pairing Module

Fig. 1

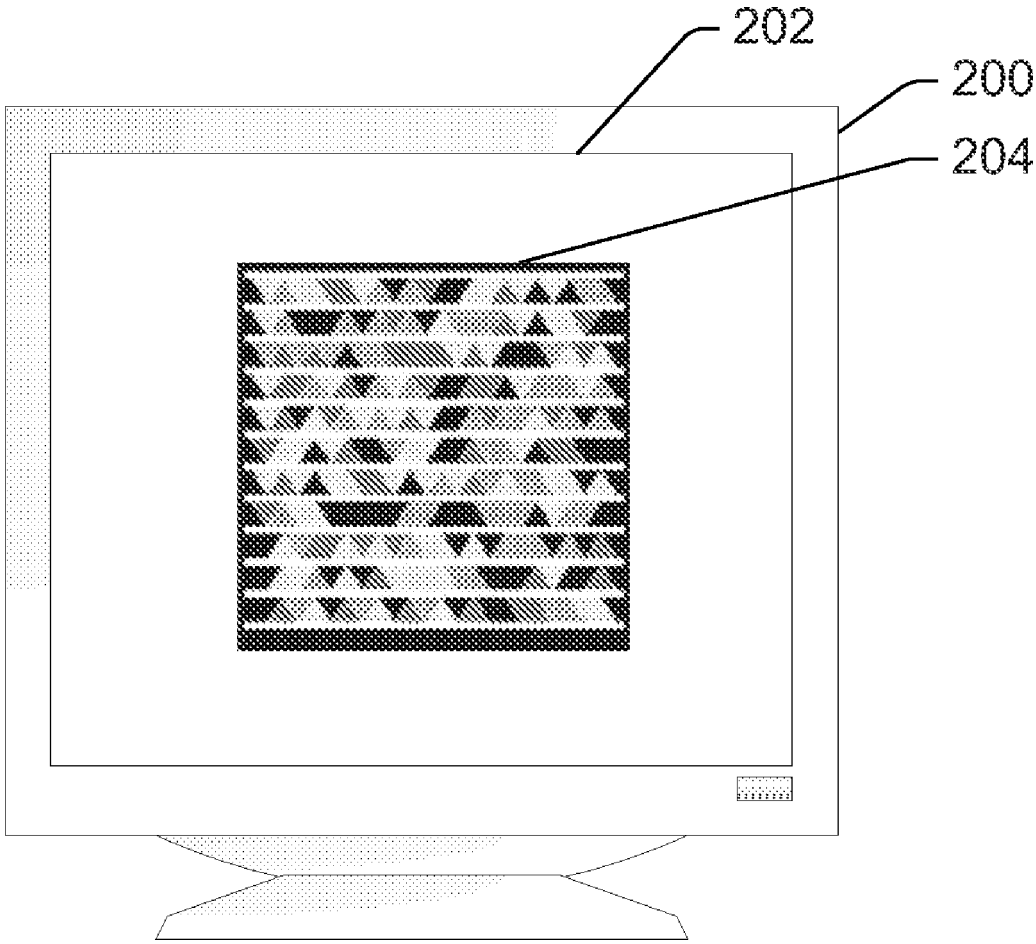



Fig. 2

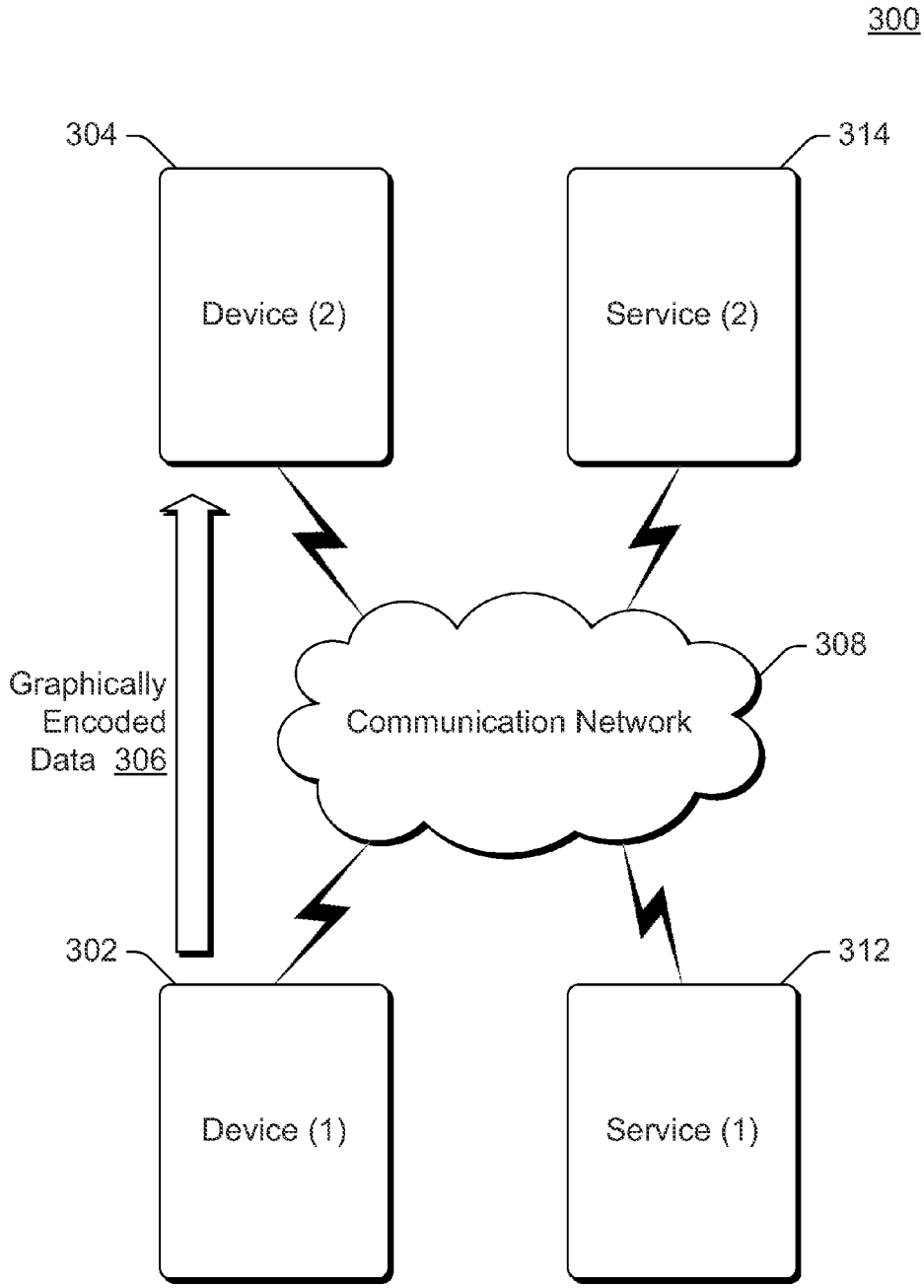

300
304
314
Device (2)
Service (2)
308
Graphically
Encoded
Data 306
Communication Network
302
312
Device (1)
Service (1)

Fig. 3

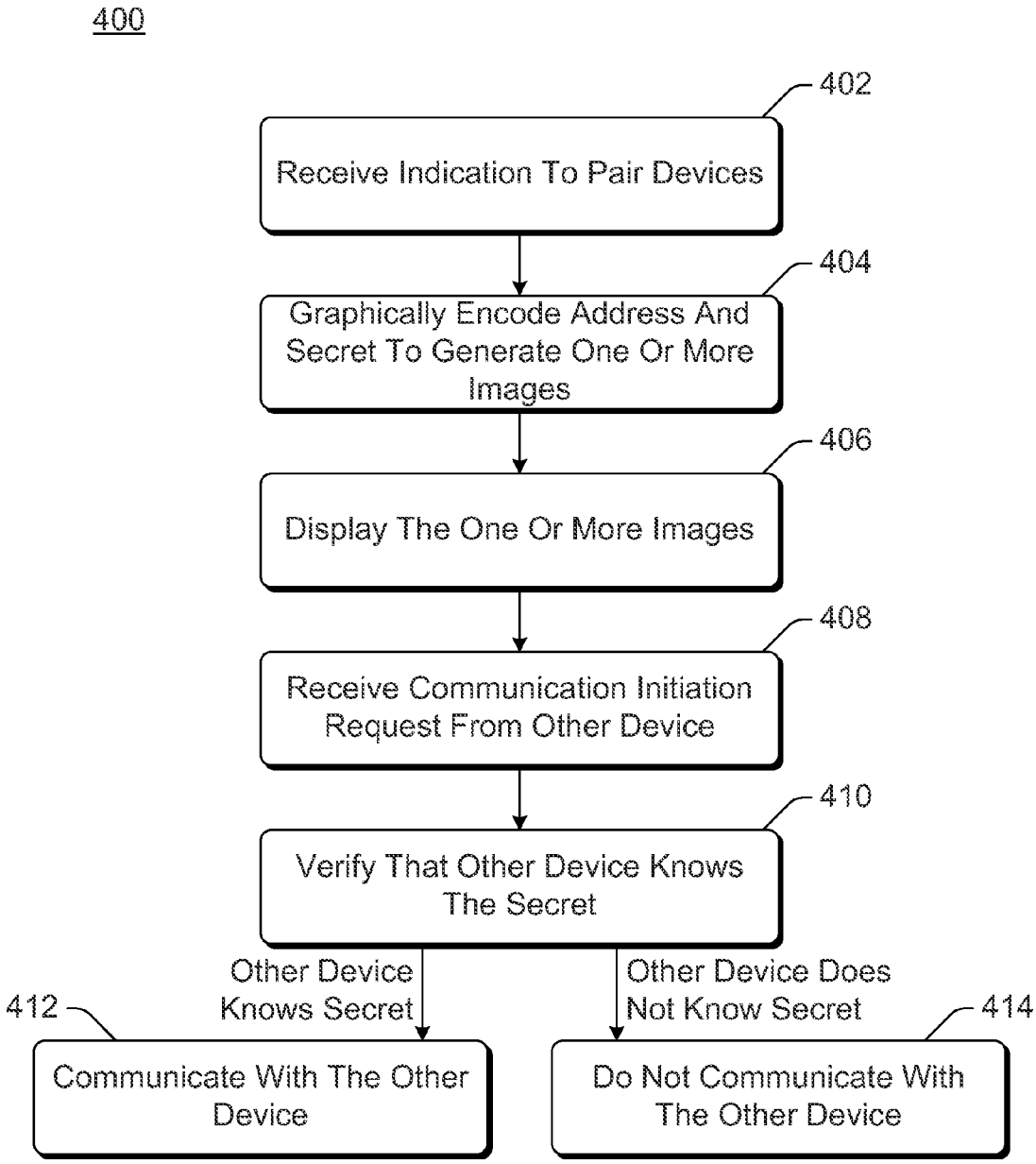

400
402
Receive Indication To Pair Devices
404
Graphically Encode Address And Secret To Generate One Or More Images
406
Display The One Or More Images
408
Receive Communication Initiation Request From Other Device
410
Verify That Other Device Knows The Secret
Other Device Knows Secret
Other Device Does Not Know Secret
412
Communicate With The Other Device
414
Do Not Communicate With The Other Device

Fig. 4

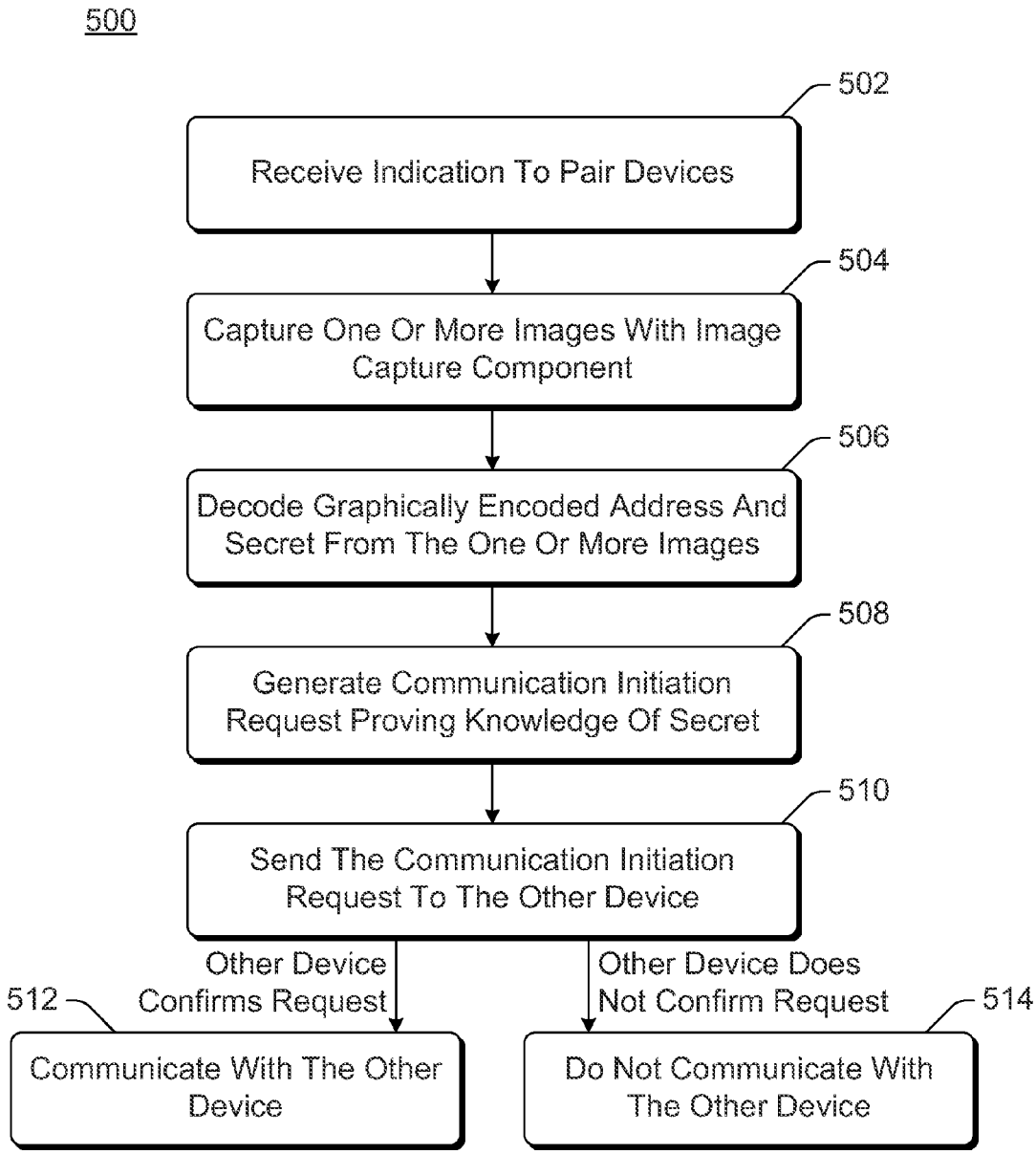

500
502
Receive Indication To Pair Devices
504
Capture One Or More Images With Image Capture Component
506
Decode Graphically Encoded Address And Secret From The One Or More Images
508
Generate Communication Initiation Request Proving Knowledge Of Secret
510
Send The Communication Initiation Request To The Other Device
Other Device Confirms Request
Other Device Does Not Confirm Request
512
Communicate With The Other Device
514
Do Not Communicate With The Other Device

Fig. 5

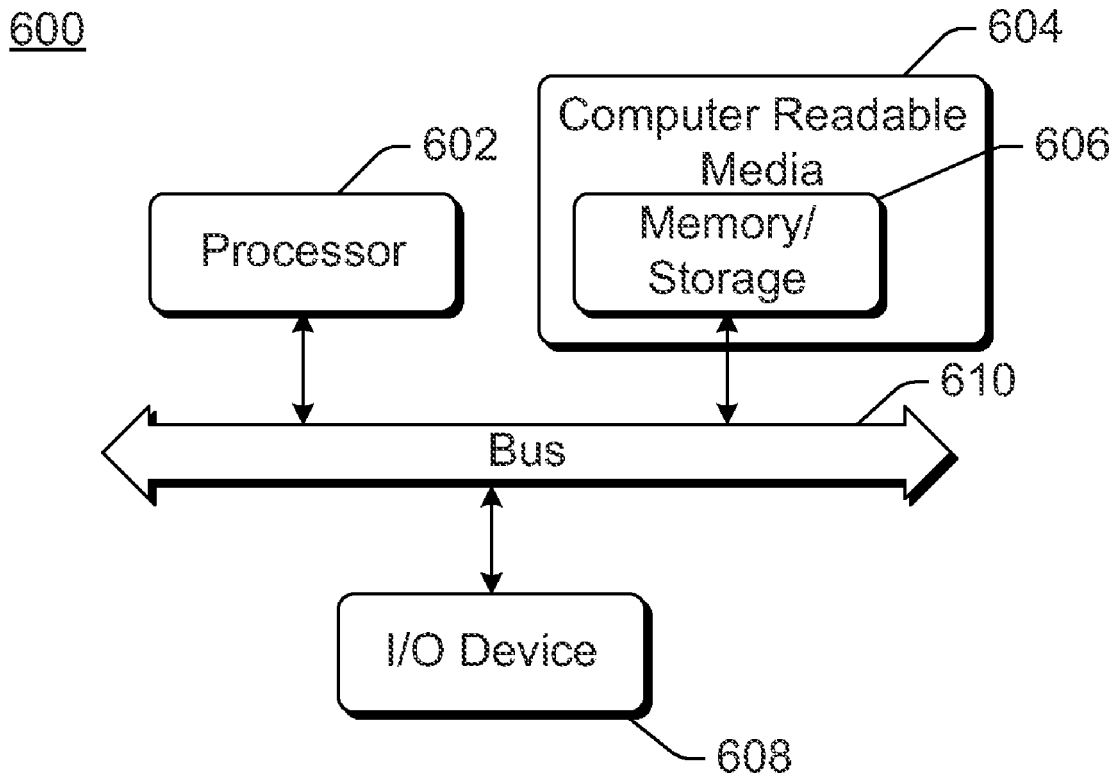

600
604
Computer Readable Media
606
602
Processor
Memory/ Storage
610
Bus
I/O Device
608

Fig. 6

# DEVICE PAIRING BASED ON GRAPHICALLY ENCODED DATA

## BACKGROUND

**[0001]** As technology has advanced, computing devices have become increasingly present in people's lives. Given the widespread usage of such devices, users oftentimes desire two devices to be able to communicate data and/or control information between one another. Current communication techniques, however, oftentimes involve a wired connection between the two devices, and/or numerous settings or other configuration changes being made by the users of the devices. Furthermore, if the users desire that the communication between the two devices be secure, current communication techniques oftentimes require the users to take additional steps to ensure that the communication between the two devices be kept secure. These communication techniques, however, can be time consuming and cumbersome on the part of the user, reducing the user friendliness of the devices.

## SUMMARY

**[0002]** This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

**[0003]** In accordance with one or more aspects, in a computing device both an address of a first device and a first secret are graphically encoded to generate one or more images that can be captured by a second device. A communication initiation request is received from the second device and, based on the communication initiation request, the second device knowing the first secret is verified. The computing device communicates with the second device only if the second device is verified as knowing the first secret.

**[0004]** In accordance with one or more aspects, in a first device one or more images displayed by a second device are captured. Both an address and a secret are decoded from the one or more images, and a communication initiation request identifying the secret is sent to the address. The first device continues communicating with the second device only if a confirmation of the communication initiation request is received.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0005]** The same numbers are used throughout the drawings to reference like features.

**[0006]** FIG. **1** illustrates an example system implementing the device pairing based on graphically encoded data in accordance with one or more embodiments.

**[0007]** FIG. **2** is a diagram illustrating an example screen display of a device in accordance with one or more embodiments.

**[0008]** FIG. **3** illustrates another example system implementing the device pairing based on graphically encoded data in accordance with one or more embodiments.

**[0009]** FIG. **4** is a flowchart illustrating an example process for a device implementing the device pairing based on graphically encoded data in accordance with one or more embodiments.

**[0010]** FIG. **5** is a flowchart illustrating another example process for a device implementing the device pairing based on graphically encoded data in accordance with one or more embodiments.

**[0011]** FIG. **6** illustrates an example computing device that can be configured to implement the device pairing based on graphically encoded data in accordance with one or more embodiments.

## DETAILED DESCRIPTION

**[0012]** Device pairing based on graphically encoded data is discussed herein. A secret is generated and both an address of a first device as well as the secret are graphically encoded by the first device and displayed for capture by a second device. An image capture component of the second device captures the graphically encoded address and secret (which is now shared by the two devices), and decodes the address and secret. The second device then sends a communication initiation request to the first device using the decoded address. As part of the communication initiation request, the second device includes an indication of an address of the second device, and also includes proof that the second device has knowledge of the secret. The first device receives the communication initiation request and verifies that the second device has knowledge of the secret. If the second device is verified as having knowledge of the secret, then the first and second devices proceed to communicate with one another; otherwise, the first and second devices do not proceed to communicate with one another.

**[0013]** References are made herein to symmetric key cryptography, public key cryptography and public/private key pairs. Although such key cryptography is well-known to those skilled in the art, a brief overview of such cryptography is included here to assist the reader. In public key cryptography, an entity (such as a user, hardware or software component, a device, a domain, and so forth) has associated with it a public/private key pair. The public key can be made publicly available, but the entity keeps the private key a secret. Without the private key it is computationally very difficult to decrypt data that is encrypted using the public key. So, data can be encrypted by any entity with the public key and only decrypted by an entity with the corresponding private key. Additionally, a digital signature for data can be generated by using the data and the private key. Without the private key it is computationally very difficult to create a signature that can be verified using the public key. Any entity with the public key can use the public key to verify the digital signature by executing a suitable digital signature verification algorithm on the public key, the signature, and the data that was signed.

**[0014]** In symmetric key cryptography, on the other hand, a symmetric key is known by and kept secret by the two entities. Any entity having the symmetric key is typically able to decrypt data encrypted with that symmetric key. Without the symmetric key it is computationally very difficult to decrypt data that is encrypted with the symmetric key. So, if two entities both know the symmetric key, each can encrypt data that can be decrypted by the other, but other entities cannot decrypt the data if the other entities do not know the symmetric key.

**[0015]** FIG. **1** illustrates an example system **100** implementing the device pairing based on graphically encoded data in accordance with one or more embodiments. System **100** includes a device **102** and a device **104**. Each of devices **102** and **104** can be a variety of different types of devices. For

example, each of device **102** and device **104** can be a desktop computer, a server computer, a netbook, a handheld computer, a personal digital assistant (PDA), a mobile station, an entertainment appliance, a set-top box communicatively coupled to a display device, a cellular or other wireless phone, a game console, an automotive computer, and so forth. Thus, each of devices **102** and **104** may range from a full resource device with substantial memory and processor resources (e.g., personal computers, game consoles) to a low-resource device with limited memory and/or processing resources (e.g., traditional set-top boxes, hand-held game consoles). Devices **102** and **104** can be the same type of device, or alternatively different types of devices.

**[0016]** Graphically encoded data **106** can be transferred from device **102** to device **104**. Accordingly, device **102** can also be referred to as a source device, and device **104** can also be referred to as a recipient device. Graphically encoded data is data that has been encoded using one or more graphical encoding techniques, resulting in one or more images that can be graphically decoded to obtain the encoded data. Although system **100** is discussed with reference to device **102** including modules supporting graphically encoding data and device **104** including modules supporting graphically decoding data, it is to be appreciated that device **104** can also include modules supporting graphically encoding data, and/or device **102** can also include modules supporting graphically decoding data.

**[0017]** Although not illustrated in FIG. **1**, devices **102** and **104** can also include various additional modules or components, including one or more applications that are run by one or more processors of device **102** or **104**. A variety of different types of modules or applications can be included in a device **102** or **104**, such as communications applications or modules for wirelessly sending data to and/or receiving data from other devices, productivity applications or modules (e.g., spreadsheets, word processors), recreational applications or modules (e.g., games), resource applications or modules (e.g., databases, digital books), audio/video applications or modules (e.g., digital cameras, digital video cameras, music playback programs), mapping or tracking applications or modules, and so forth.

**[0018]** Communication network **108** allows device **102** to communicate with one another. Communication network **108** can be a variety of different networks, including the Internet, a local area network (LAN), a public telephone network, an intranet, other public and/or proprietary networks, combinations thereof, and so forth. Communication between devices **102** and **104** is initiated by device **102** notifying device **104**, using graphically encoded data **106**, of an address of device **102**. This address identifies device **102** on communication network **108**. Given this address (and optionally other information regarding the location of device **102**), other devices on network **108** can send messages to device **102**. Device **104** can use the address (and optionally other information regarding the location of device **102**) to notify device **102** of an address of device **104** (which identifies device **104** on communication network **108**). Given this address (and optionally other information regarding the location of device **104**), other devices on network **108** can send messages to device **104**. This initiation of communication is also referred to as pairing devices **102** and **104** because devices **102** and **104** are paired together and able to communicate with one another after the initiation process.

**[0019]** Device **102** includes a screen **112**, an input module **114**, a user interface (UI) module **116**, a graphical encoding module **118**, and a device pairing module **120**. Each of modules **114**, **116**, **118**, and **120** can be implemented in software, firmware, hardware, or combinations thereof. When implemented in software or firmware, such a module includes one or more instructions that are executed by one or more processors or controllers of device **102**.

**[0020]** Screen **112** is a display component of device **102**. Screen **112** can be implemented in a variety of different manners, such as using liquid crystal display (LCD) technology, plasma screen technology, image projection technology, and so forth. Alternatively, rather than including screen **112**, screen **112** can be separate from device **102** and device **102** can generate one or more signals that are output to one or more other display devices that include screen **112**.

**[0021]** Input module **114** receives user inputs from a user of device **102**. User inputs can be provided in a variety of different manners, such as by pressing a particular portion of a touchpad or touchscreen of device **102**, by entering one or more gestures (e.g., particular shapes or patterns) on a touchpad or touchscreen of device **102**, or pressing one or more keys of a keypad or keyboard of device **102**. Touchscreen functionality can be provided using a variety of different technologies, such as through capacitive, surface acoustic wave, resistive, optical, strain gauge, dispersive signals, acoustic pulse, or other touchscreen technologies. The user input can also be provided in other manners, such as via audible inputs, other physical feedback input to the device (e.g., tapping any portion of device **102** or another action that can be recognized by a motion detection component of device **102**, such as shaking device **102**, rotating device **102**, etc.), and so forth.

**[0022]** UI module **116** generates, manages, and/or outputs a user interface for display on screen **112**. This user interface displays various information on screen **112**, and user inputs can be received by input module **114** as discussed above. UI module **116** can display, for example, images generated by applications or modules of device **102**, messages sent by device **102** to other devices, messages received by device **102** from other devices, and so forth.

**[0023]** Graphical encoding module **118** graphically encodes data to be transferred from device **102** to device **104** as graphically encoded data **106**, which is used to initiate communication between devices **102** and **104** as discussed in more detail below. Module **118** can graphically encode data using a variety of different graphical encoding techniques. In one or more embodiments, module **118** generates a barcode, such as a high capacity color barcode (HCCB), a QR barcode, other one-dimensional or multi-dimensional barcodes, and so forth. Alternatively, module **118** can graphically encode data using a variety of other techniques that result in an image that can be graphically decoded to obtain the data encoded in the image.

**[0024]** Device pairing module **120** manages, for device **102**, the pairing of or initiation of communication between devices **102** and **104**. Device pairing module **120** obtains data including both an address of device **102** and a secret. The address of device **102** can be a variety of different identifiers or information that identifies device **102** on communication network **108**. Additional location information can also optionally be used by other devices on communication network **108** to, in conjunction with the address, determine how to communicate with device **102**. The address of device **102**

can vary based on the protocol used by communication network **108**. In one or more embodiments, the address of device **102** is an IP (Internet Protocol) address, such as an IPv4 or IPv6 address. The address of device **102** can be obtained by device pairing module **120** in a variety of different manners, such as from another component or module of device **102**, from a setting or configuration store of device **102**, and so forth.

**[0025]** The secret is a value that is intended to be known to only device **102** and device **104**, thus allowing devices **102** and **104** to know they are being paired with each other rather than with some other device. In one or more embodiments, the secret is a string of characters such as numbers and/or letters. Alternatively, the secret can be other characters, symbols, and so forth. The secret can be a cryptographic key, or alternatively another string of characters, symbols, etc.

**[0026]** Device pairing module **120** can obtain the secret in a variety of different manners. In one or more embodiments, module **120** generates a random number or other string of characters that is used as the secret. In other embodiments, module **120** obtains the secret from another component or module of device **102**.

**[0027]** Device pairing module **120** provides both the obtained address of device **102** and the secret to graphical encoding module **118**. Graphical encoding module **118**, in turn, graphically encodes the obtained address and secret to generate one or more images. Device pairing module **120** can also optionally provide additional location information regarding device **102** to graphical encoding module **118**, which encodes the additional location information in the one or more images. Module **118** can encode both the obtained address and the secret into the same image, or alternatively can encode the obtained address and/or the secret across multiple images as discussed in more detail below. These one or more images are then displayed on screen **112**. The display of these one or more images on screen **112** can be managed by UI module **116**, graphical encoding module **118**, device pairing module **120**, or alternatively another module of device **102**. These images displayed on screen **112** are the graphically encoded data **106** being transferred to device **104**.

**[0028]** The amount of time the one or more images are displayed on the screen can vary. In one or more embodiments, the amount of time the one or more images are displayed is time-based. For example, the one or more images can be displayed for a specific amount of time (e.g., 15 seconds, 30 seconds, etc.). In other embodiments, the amount of time the one or more images are displayed is based on some other event. For example, the one or more images can be displayed until a communication initiation request is received from another device (e.g., device **104**), as discussed in more detail below.

**[0029]** The images encoding the address and secret are generated and can be displayed in response to a variety of different events or actions. For example, the images can be generated and displayed in response to device **102** being powered on. Alternatively, the images can be generated and displayed in response to a user request or a request from another component, module, device. For example, the images can be generated and displayed in response to a device pairing request input by a user via input module **134**, such as by user selection of a "device pairing" button or menu item, tapping device **104**, entering a particular gesture, and so forth.

**[0030]** FIG. **2** is a diagram illustrating an example screen display of a device **200** in accordance with one or more embodiments. Device **200** can be, for example, a device **102** of FIG. **1**. Device **200** includes a screen **202** on which an image **204** is displayed. The image is a graphically encoded address and secret (e.g., as obtained by device pairing module **120** as discussed above). Although illustrated as a non-colorized image, it is to be appreciated that image **210** can include various colors (e.g., as an HCCB image).

**[0031]** Returning to FIG. **1**, device **104** includes an image capture component **130**, a screen **132**, an input module **134**, a UI module **136**, a graphical decoding module **138**, and a device pairing module **140**. Each of modules **134**, **136**, **138**, and **140** can be implemented in software, firmware, hardware, or combinations thereof. When implemented in software or firmware, such a module includes one or more instructions that are executed by one or more processors or controllers of device **102**. Alternatively, device **104** need not include one or more of screen **132**, component **130**, and/or one or more modules **134-140**. For example, device **104** may not include screen **132** or input module **134**.

**[0032]** Screen **132** is a display component of device **104** (or a separate display device), analogous to screen **112** of device **102**. Input module **134** receives inputs from a user of device **104**, analogous to input module **114** of device **102**. UI module **136** generates, manages, and/or outputs a user interface for display on screen **132**, analogous to UI module **116** of device **102**.

**[0033]** Image capture component **130** captures images for use by device **104**, including images displayed on screen **112**. Image capture component **130** can also be referred to as a camera or digital camera. A variety of different technologies can be used to implement image capture component **130**, such as CCD (charge coupled device) technology, CMOS (complementary metal oxide semiconductor) technology, and so forth. Although illustrated as being part of device **104**, alternatively component **130** can be a separate device (e.g., a camera coupled to device **104**).

**[0034]** Image capture component **130** can determine when to capture an image displayed by device **102** on screen **112** in a variety of different manners. In one or more embodiments, the image is captured by component **130** in response to a capture request input by a user via input module **134**, such as by user selection of a "capture" button or menu item, user selection of a "device pairing" button or menu item, tapping device **104**, entering a particular gesture, and so forth. This allows the user of device **104** to position device **104** appropriately so that screen **112** is in view of a lens or other opening of device **104**, allowing component **130** to capture the image displayed on screen **112**. For example, device **104** can switch to a camera mode in response to a user request (e.g., a user request to pair device **104** with another device), displaying on screen **132** a view being seen by image capture component **130**. The user can then position device **104** appropriately so that the image on screen **112** is being seen by image capture component **130**, and then input a capture request.

**[0035]** Alternatively, the user of device **104** can enter a request to pair device **104** with another device, in response to which component **130** begins capturing images at regular or irregular intervals until one or more images that graphically encode data are captured. Device **104** can distinguish images that graphically encode data from images that do not graphically encode data in different manners, such as based on a known signature or other value encoded into each graphically encoded image by module **118**.

**[0036]** In other alternatives, component **130** can begin capturing images at regular or irregular intervals in response to some other request or event rather than a user request to pair device **104** with another device. For example, component **130** can begin capturing images when device **104** is powered on, when image capture component **130** is powered on, and so forth. Component **130** continues capturing the images until one or more images that graphically encode data are captured or alternatively some other event occurs (e.g., after a threshold amount of time has passed or a threshold number of images are captured).

**[0037]** Graphical decoding module **138** graphically decodes data transferred from device **102**. Module **138** can graphically decode data using a variety of different graphical decoding techniques. The particular technique used by module **138** depends on the particular graphical encoding technique used by graphical encoding module **118** of device **102** to encode the data. In one or more embodiments, graphical encoding module **118** and graphical decoding module **138** are configured with or otherwise aware of the particular graphical encoding technique being used, and module **138** can thus readily decode data encoded by module **118**. Alternatively, graphical decoding module **138** can automatically detect the particular graphical encoding technique being used in a variety of different manners. For example, module **138** can determine the graphical encoding technique being used based on characteristics of the image (e.g., whether the image is black and white or includes color, whether symbols in the image are triangles or other shapes, etc.) in which the data is encoded.

**[0038]** By way of another example, module **138** can determine the graphical encoding technique being used based on an identifier encoded in the image (e.g., a particular portion of the image that decodes to a particular value for a particular graphical encoding technique). Module **138** can decode the image assuming the image was encoded using one graphical encoding technique and check whether the particular portion decodes to the particular value—if the particular portion decodes to the particular value then module **138** knows that one graphical encoding technique was used to encode the image, otherwise module **138** can repeatedly select different graphical encoding techniques until the particular portion decodes to the particular value.

**[0039]** Graphical pairing module **140** manages, for device **104**, the pairing or initiation of communication between devices **102** and **104**. The images displayed on screen **112** as graphically encoded data **106** are captured by image capture component **130** and provided to graphical decoding module **138**. Graphical decoding module **138** decodes the data encoded in the images and provides the decoded data to graphical pairing module **140**.

**[0040]** Device pairing module **140** receives this decoded data, which is the address of device **102** and the secret. As both device **102** and **104** now have the secret, this secret is also referred to as a shared secret. Additional location information regarding device **102** can also be included in the decoded data as discussed above. Based on this decoded data, device pairing module **140** generates a communication initiation request that targets (e.g., is addressed to) device **102**. The address of device **102** is known given the decoded data. Device pairing module **140** also generates the communication initiation request identifying the secret to prove that device **104** has knowledge of the secret that was obtained by device pairing module **120** as discussed above. Device pairing module **140** can generate the communication initiation request to prove it has knowledge of the secret in a variety of different manners. For example, device pairing module **140** can include the secret in unencrypted form in the communication initiation request. By way of another example, a variety of different conventional encryption techniques and/or secure communication techniques can be used by device **104** to inform, in a secure manner, device **102** that device **104** has knowledge of the secret.

**[0041]** Additionally, device pairing module **140** also includes in the communication initiation request, an address of device **104**. Additional location information can also optionally be included in the communication initiation request to allow other devices on communication network **108** to, in conjunction with the address, determine how to communicate with device **102**. This address of device **104** can be a variety of different information (such as an IP address), analogous to the address of device **102** discussed above.

**[0042]** Device pairing module **140** sends the communication initiation request to device **102**. At device **102** in response to the communication initiation request, device pairing module **120** obtains the secret from the communication initiation request. The particular manner in which the secret is obtained from the communication initiation request is dependent on the manner in which device pairing module **140** generated the communication initiation request to prove it has knowledge of the secret. For example, the secret can be retrieved in unencrypted form from the communication initiation request, or can be retrieved from or obtained based on the communication initiation request using a variety of different conventional encryption techniques and/or secure communication techniques.

**[0043]** Device pairing module **120** verifies that the communication initiation request proves that device **104** has knowledge of the secret. This verification can be performed in a variety of different manners and is dependent on the particular encryption techniques and/or secure communication techniques (if any) used by device pairing module **140**.

**[0044]** After device pairing module **120** verifies that the communication initiation request proves that device **104** has knowledge of the secret, device pairing module **120** can proceed with communicating with device **104**. The communication initiation request includes an address of device **104** as discussed above (and optionally other location information), and device pairing module **120** can return a confirmation message to device **104** notifying device **104** that device **104** has been confirmed as having knowledge of the secret key. Devices **102** and **104** are now aware of each other's addresses (e.g., IP addresses) and optionally other location information, and can proceed with communicating with one another, sending messages including data, control information, and so forth to one another. It is also to be appreciated that various conventional encryption and/or secure communication techniques can optionally be used to provide secure communication between devices **102** and **104**.

**[0045]** It is to be appreciated that, by including the secret in graphically encoded data **106**, devices **102** can be assured that the only devices having knowledge of the secret are those devices that are able to capture the image displayed on screen **112**. Accordingly, a malicious device that accesses communication network **108** would not be able to provide a verifiable communication initiation request to device **102** claiming to be device **104** because such a malicious device would not have the secret that was encoded in the displayed image.

**[0046]** It should be noted that graphical encoding module **118** can alternatively generate multiple images for display on screen **112**, encoding the address of device **102** and/or the secret across multiple images. The multiple images are then displayed (individually or concurrently) on screen **112**. Component **130** of device **104** captures the multiple images, decodes each image, and then re-assembles the data.

**[0047]** The proper sequence of the multiple images can be encoded in one or more of the images so that the data can be re-assembled in the proper order. By encoding the proper sequence in one or more of the images, the images need not be displayed by device **102** and captured by device **104** in any particular order. Alternatively, no indication of the proper sequence may be encoded in the images; rather, device **104** relies on the images being displayed by device **102** in the proper order so that the data can be properly re-assembled.

**[0048]** In one or more embodiments, each of the multiple images has encoded in it an indication of which portion that image is (e.g., the first portion, the second portion, the third portion, etc.). In other embodiments, one or more of the multiple images has encoded in it an indication of the sequence of the images. For example, a single image can have a listing of the ordering of the images, with the different images being identified in the listing with identifiers that are encoded in each of the multiple images, with signatures of the images, with particular portions of the images that allow the different images to be distinguished from one another, and so forth. In other embodiments, an indication of the sequence of images can be encoded as an individual image rather than being encoded with a portion of the data being copied.

**[0049]** Device **102** can display the multiple images in different manners. For example, device **102** can display each of the multiple images for an amount of time, then automatically switch to displaying a next one of the multiple images, continuing until all of the multiple images have been displayed. The multiple images can each be displayed once, or alternatively can be cycled through and displayed multiple times. By way of another example, device **102** can display an image until a user request is received via input module **114** to display another of the multiple images. The user request is input, for example, after the image has been captured by device **104**.

**[0050]** Device **104** can similarly capture the multiple images in different manners. For example, device **104** can automatically capture images as they are displayed on screen **112**, or alternatively capture images in response to a user request to capture an image input via input module **134**.

**[0051]** FIG. **3** illustrates another example system **300** implementing the device pairing based on graphically encoded data in accordance with one or more embodiments. System **300** is similar to system **100** of FIG. **1**, including a communication network **308** analogous to communication network **108** of FIG. **1**, and graphically encoded data **306** analogous to graphically encoded data **106** of FIG. **1**.

**[0052]** System **300** also includes devices **302** and **304**, which can include at least some of the same functionality as devices **102** and **104** of FIG. **1**, respectively. However, system **300** also includes service **312** and service **314**. Service **312** is implemented in one or more devices physically separate from (and typically at a remote location from) device **302**. Similarly, service **314** is implemented in one or more devices physically separate from (and typically at a remote location from) device **304**. Each of services **312** and **314** can be implemented using a variety of different devices, analogous to devices **102** and **104** of FIG. **1**.

**[0053]** Service **312** provides support functionality to device **302**. One or more of the operations performed by graphical encoding module **118** and/or device pairing module **120** can be performed by service **312** rather than device **302**. For example, the secret can be generated by service **312** and provided to device **302**, one or both of the address and secret can be graphically encoded by service **312** and provided to device **302**, and so forth.

**[0054]** In one or more embodiments, device **302** operates at least in part as a terminal that is controlled by service **312**, displaying whatever graphically encoded data is desired by service **312** at the time, verifying that device **304** has knowledge of the secret, and so forth. Accordingly, it is to be appreciated that the address encoded in graphically encoded data **306** can be the address of one or more devices of service **312** rather than an address of device **302**. In such situations, although the user of device **304** may be given the impression that he or she is communicating with device **302**, the communication is actually with one or more devices of service **312**.

**[0055]** Similarly, service **314** provides support functionality to device **304**. One or more of the operations performed by graphical encoding module **138** and/or device pairing module **140** can be performed by service **314** rather than device **304**. For example, the captured image can be forwarded to service **314**, which in turn decodes the graphically encoded data and provides the decoded address and secret to device **304**.

**[0056]** In the discussions above, the displayed image includes a graphical encoding of the secret, and the communication initiation request proves that the device that captured the image has knowledge of the secret. This use of the secret assures device **102** that the device from which the communication initiation request is received is indeed a device to which the graphically encoded secret was displayed. However, in situations where such assurance is not desired and/or needed by device **102**, the secret need not be used. Rather, graphical encoding module **118** can generate an image for display on screen **112** by graphically encoding the address of device **102**. As there is no secret encoded in the image in such situations, no verification of the secret is performed by device pairing module **140**.

**[0057]** Using the techniques discussed herein, two devices can be easily paired by a user. For example, a user can press a "device pairing" button of a first device, in response to which the first device displays the image of the graphically encoded address and secret as discussed above. The user then positions the second device so that the displayed image can be captured, and presses a "device pairing" button of the second device to have the second device capture the displayed image. Communication between the two devices is initiated without the need for any additional input by the user. Communication between the two devices can thus be easily initiated, with cumbersome processes for configuring the devices to be able to communicate with one another being avoided.

**[0058]** The device pairing based on graphically encoded data discussed herein supports various usage scenarios. Anywhere communication between two devices is desired, the techniques discussed herein can be used to initiate communication between those two devices. For example, the techniques can be used to initiate communication between two devices to transfer data (e.g., a report, song, or other data from one device to another). By way of another example, the techniques can be used to initiate communication to allow one device to control another (e.g., so images or other files from

one device can be displayed on another, so that one device can change the operation of the other, and so forth).

**[0059]** FIG. **4** is a flowchart illustrating an example process **400** for a device implementing the device pairing based on graphically encoded data in accordance with one or more embodiments. Process **400** is carried out by one or more devices, such as device **102** of FIG. **1**, or device **302** and/or a device of service **312** of FIG. **3**, and can be implemented in software, firmware, hardware, or combinations thereof. Process **400** is illustrated as a set of acts, although the acts need not be performed in the order illustrated in FIG. **4**. Process **400** is an example process for device pairing based on graphically encoded data; additional discussions of device pairing based on graphically encoded data are included herein with reference to different figures.

**[0060]** In process **400**, an indication to pair devices is received (act **402**). This indication can be a user request (e.g., via selection of a button, key or other input via an input module **114**). This indication can alternatively be an indication received from another component or module of the device implementing process **400**, or from another device.

**[0061]** Both an address of a device and a secret are graphically encoded to generate one or more images (act **404**). The device whose address is identified can be the device implementing process **400**, or alternatively another device (e.g., a device of a remote service supporting the device implementing process **400**). The device whose address is identified is the device responsible for managing the display of information on and/or controlling the operation of the device implementing process **400**. The device implementing process **400** can perform the graphical encoding, or alternatively can provide the address and secret to another device or service to perform the graphical encoding.

**[0062]** The one or more images generated in act **404** are displayed (act **406**). As discussed above, these images can be displayed on a screen of the device implementing process **400**, or alternatively on a screen of a display device receiving signals from the device implementing process **400**.

**[0063]** After displaying the one or more images, a communication initiation request is received from another device (act **408**). This other device is typically the other device to which the device implementing process **400** is being paired. However, in order to ensure that this is the case, the device implementing process **400** verifies that the device from which the communication initiation request is received knows the secret (act **410**). This secret in act **410** is the secret that was graphically encoded in act **404**, and this verification can be performed in a variety of different manners as discussed above.

**[0064]** Process **400** then proceeds based on the verification in act **410**. If the other device is verified as knowing the secret in act **410**, then the device implementing process **400** can proceed with communicating with that other device (act **412**).

**[0065]** However, if the other device is not verified as knowing the secret in act **410**, then the device implementing process **400** does not proceed with communicating with that other device (act **414**). Even though the device implementing process **400** does not proceed with communicating with that other device, it is to be appreciated that subsequent communication initiation requests from that other device can still be received and verified, and subsequent communications allowed if a subsequent communication initiation request is received and verified.

**[0066]** It should be noted that the secret discussed herein can be a variety of different data that can be used by devices **102** and **104** to initiate secure communications using a variety of different encryption and/or secure communication techniques. For example, the secret can be a randomly generated value or string, a value or string generated according to some other rules or criteria, a public key of device **102**, a digital certificate (or portion thereof) issued to device **102**, and so forth.

**[0067]** FIG. **5** is a flowchart illustrating another example process **500** for a device implementing the device pairing based on graphically encoded data in accordance with one or more embodiments. Process **500** is carried out by one or more devices, such as device **104** of FIG. **1**, or device **304** and/or a device of service **314** of FIG. **3**, and can be implemented in software, firmware, hardware, or combinations thereof. Process **500** is illustrated as a set of acts, although the acts need not be performed in the order illustrated in FIG. **5**. Process **500** is an example process for device pairing based on graphically encoded data; additional discussions of device pairing based on graphically encoded data are included herein with reference to different figures.

**[0068]** In process **500**, an indication to pair devices is received (act **502**). This indication can be a user request (e.g., via selection of a button, key or other input via an input module **134**). This indication can alternatively be an indication received from another component or module of the device implementing process **500**, or from another device.

**[0069]** One or more images are captured with an image capture component of the device implementing process **500** (act **504**). These images are the images displayed by the device with which the device implementing process **500** is being paired (e.g., device **102**), as discussed above. It should be noted that both the indication can be received in act **502** and the one or more images captured in response to a single user request (e.g., a capture request or selection of a "device pairing" button).

**[0070]** The graphically encoded data from the one or more images is decoded (act **506**), resulting in a decoded address and a decoded secret. Based on the decoded address and secret, a communication initiation request is generated (act **508**) proving that the device implementing process **500** has knowledge of the secret. This communication initiation request can be generated in a variety of different manners as discussed above.

**[0071]** The communication initiation request is sent to the other device (act **510**). This communication initiation request identifies the secret, as discussed above. This other device is the device whose address was graphically encoded in the one or more images captured in act **504**. Process **500** then proceeds based on whether the other device confirms the request. If the other device confirms the request, then the device implementing process **500** can continue with communicating with that other device (act **512**).

**[0072]** However, if the other device does not confirm the request, then the device implementing process **500** ceases (does not continue with) communicating with that other device (act **514**). Even though the device implementing process **500** does not continue communicating with that other device, it is to be appreciated that subsequent indications to pair devices with that other device can be received, and subsequent communication initiation requests sent to that other device (and subsequent communications allowed with that other device if a subsequent communication initiation request is confirmed by that other device).

**[0073]** FIG. **6** illustrates an example computing device **600** that can be configured to implement the device pairing based on graphically encoded data in accordance with one or more embodiments. Computing device **600** can be, for example, device **102** or device **104** of FIG. **1**, device **302** or device **304** of FIG. **3**, or a device implanting at least part of a service **312** or **314** of FIG. **3**.

**[0074]** Computing device **600** includes one or more processors or processing units **602**, one or more computer readable media **604** that can include one or more memory and/or storage components **606**, one or more input/output (I/O) devices **608**, and a bus **610** that allows the various components and devices to communicate with one another. Computer readable media **604** and/or one or more I/O devices **608** can be included as part of, or alternatively may be coupled to, computing device **600**. Bus **610** represents one or more of several types of bus structures, including a memory bus or memory controller, a peripheral bus, an accelerated graphics port, a processor or local bus, and so forth using a variety of different bus architectures. Bus **610** can include wired and/or wireless buses.

**[0075]** Memory/storage component **606** represents one or more computer storage media. Component **606** can include volatile media (such as random access memory (RAM)) and/or nonvolatile media (such as read only memory (ROM), Flash memory, optical disks, magnetic disks, and so forth). Component **606** can include fixed media (e.g., RAM, ROM, a fixed hard drive, etc.) as well as removable media (e.g., a Flash memory drive, a removable hard drive, an optical disk, and so forth).

**[0076]** The techniques discussed herein can be implemented in software, with instructions being executed by one or more processing units **602**. It is to be appreciated that different instructions can be stored in different components of computing device **600**, such as in a processing unit **602**, in various cache memories of a processing unit **602**, in other cache memories of device **600** (not shown), on other computer readable media, and so forth. Additionally, it is to be appreciated that the location where instructions are stored in computing device **600** can change over time.

**[0077]** One or more input/output devices **608** allow a user to enter commands and information to computing device **600**, and also allows information to be presented to the user and/or other components or devices. Examples of input devices include a keyboard, a cursor control device (e.g., a mouse), a microphone, a scanner, and so forth. Examples of output devices include a display device (e.g., a monitor or projector), speakers, a printer, a network card, and so forth.

**[0078]** Various techniques may be described herein in the general context of software or program modules. Generally, software includes routines, programs, objects, components, data structures, and so forth that perform particular tasks or implement particular abstract data types. An implementation of these modules and techniques may be stored on or transmitted across some form of computer readable media. Computer readable media can be any available medium or media that can be accessed by a computing device. By way of example, and not limitation, computer readable media may comprise "computer storage media" and "communications media."

**[0079]** "Computer storage media" include volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information such as computer readable instructions, data structures, program modules, or other data. Computer storage media include, but are not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to store the desired information and that can be accessed by a computer.

**[0080]** "Communication media" typically embody computer readable instructions, data structures, program modules, or other data in a modulated data signal, such as carrier wave or other transport mechanism. Communication media also include any information delivery media. The term "modulated data signal" means a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media include wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, RF, infrared, and other wireless media. Combinations of any of the above are also included within the scope of computer readable media.

**[0081]** Generally, any of the functions or techniques described herein can be implemented using software, firmware, hardware (e.g., fixed logic circuitry), manual processing, or a combination of these implementations. The terms "module" and "component" as used herein generally represent software, firmware, hardware, or combinations thereof. In the case of a software implementation, the module or component represents program code that performs specified tasks when executed on a processor (e.g., CPU or CPUs). The program code can be stored in one or more computer readable memory devices, further description of which may be found with reference to FIG. **6**. The features of the device pairing based on graphically encoded data techniques described herein are platform-independent, meaning that the techniques can be implemented on a variety of commercial computing platforms having a variety of processors.

**[0082]** Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

What is claimed is:

**1**. A method implemented in a computing device, the method comprising:

graphically encoding both an address of a first device and a first secret to generate one or more images that can be captured by a second device;

receiving a communication initiation request from the second device;

verifying, based on the communication initiation request, that the second device knows the first secret; and

communicating with the second device only if the second device is verified as knowing the first secret.

**2**. A method as recited in claim **1**, wherein the computing device comprises the first device, and the method further comprising displaying the one or more images.

**3**. A method as recited in claim **2**, further comprising graphically encoding both the address and the first secret, and displaying the one or more images, in response to a user request to pair the computing device with another device.

**4**. A method as recited in claim **3**, wherein the user request is user selection of a device pairing button.

**5**. A method as recited in claim **1**, wherein graphically encoding both the address and the first secret comprises graphically encoding both the address and the first secret across multiple images.

**6**. A method as recited in claim **1**, wherein the first device and the computing device are two separate devices, and the method further comprises providing the one or more images to the first device for display by the first device.

**7**. A method as recited in claim **1**, wherein the address comprises an IP address of the first device.

**8**. A method as recited in claim **1**, further comprising:

obtaining, from the communication initiation request, a second secret;

determining whether the second secret is the same as the first secret; and

wherein verifying that the second device knows the first secret comprises verifying that the second device knows the first secret only if the second secret is the same as the first secret.

**9**. A method as recited in claim **1**, wherein graphically encoding both the address and the first secret comprises graphically encoding both the address and the first secret using a high capacity color barcode.

**10**. A method as recited in claim **1**, wherein the communication initiation request includes an address of the second device, and the method further comprises sending a confirmation indication to the second device indicating receipt of the communication initiation request and verification that the second device knows the first secret.

**11**. A method as recited in claim **10**, wherein the address of the second device comprises an IP address of the second device.

**12**. One or more computer storage media having stored thereon instructions that, when executed by one or more processors of a first device, cause the one or more processors to:

capture one or more images displayed by a second device;

decode, from the one or more images, both an address and a secret;

send a communication initiation request to the address, the communication initiation request identifying the secret; and

continuing communicating with the second device only if a confirmation of the communication initiation request is received.

**13**. One or more computer storage media as recited in claim **12**, wherein the address is an IP address of the second device.

**14**. One or more computer storage media as recited in claim **12**, wherein the address is an address of a third device that provides the one or more images to the second device.

**15**. One or more computer storage media as recited in claim **12**, wherein to decode both the address and the secret is to send the one or more images to a remote service and receive, from the remote service, the address and the secret.

**16**. One or more computer storage media as recited in claim **12**, wherein the communication initiation request includes an address of the first device.

**17**. One or more computer storage media as recited in claim **12**, wherein each of the one or more images is a high capacity color barcode.

**18**. One or more computer storage media as recited in claim **12**, wherein the one or more processors perform the capture, decode, and send in response to a request to pair the first device with another device.

**19**. One or more computer storage media as recited in claim **12**, wherein the one or more images comprises multiple images, and wherein to decode both the address and the secret is to decode at least part of the address from a first image of the multiple images, and decode at least part of the secret from a second image of the multiple images.

**20**. A method implemented in a first device, the method comprising:

capturing, in response to a user request for device pairing, a high capacity color barcode displayed on a screen of a second device;

decoding, from the high capacity color barcode, both an IP address of the second device and a secret;

sending, a communication initiation request to the IP address of the second device, the communication initiation request proving that the first device has knowledge of the secret; and

if a confirmation of the communication initiation request is received from the second device, then sending additional communications to the IP address of the second device, otherwise ceasing sending communications to the IP address of the second device.

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