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(71) Applicant(s):
Intercede Limited
(Incorporated in the United Kingdom)
Lutterworth Hall, St Mary's Road, LUTTERWORTH, Leicestershire, LE17 4PS, United Kingdom

(72) Inventor(s):
Christopher Paul Edwards

(74) Agent and/or Address for Service:
Olswang LLP
90 High Holborn, LONDON, WC1V 6XX, United Kingdom

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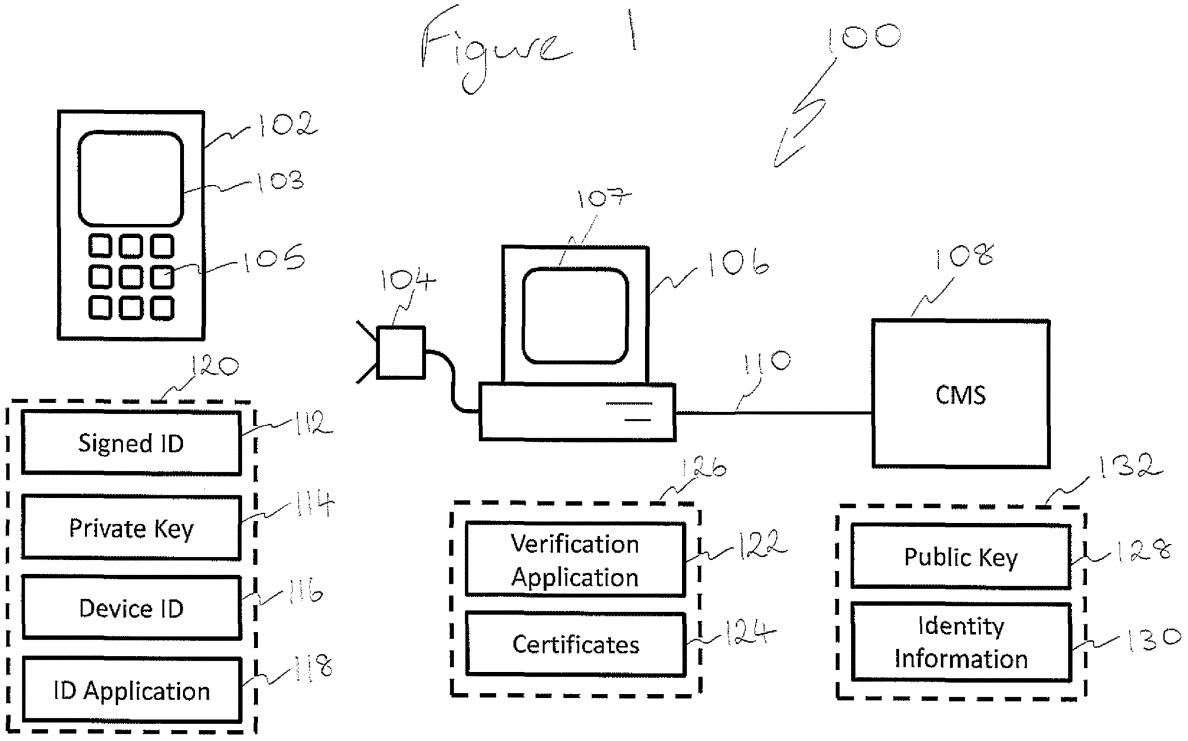
(54) Title of the Invention: **Identity verification**
Abstract Title: **Identity verification**

(57) Methods and devices are disclosed for providing verifiable identity information using a mobile device such as a smartphone 102, the method comprising receiving a challenge value, from a guard device 106, at the mobile device, generating a response value based on the challenge value and a private key 114 associated with the mobile device, and providing the response value and identity information (eg the IMEI value associated with the mobile device) to the guard device, following which they may be verified by a credential management system (CMS) 108 with access a the public key 128. The challenge and/or response may be transmitted to/from the mobile device via a barcode such as a quick response (QR) code, or via a radio, near field or infra-red interface. Alternatively, the challenge may be displayed on a screen 107 of the guard device and manually input into the mobile device.

Figure 1



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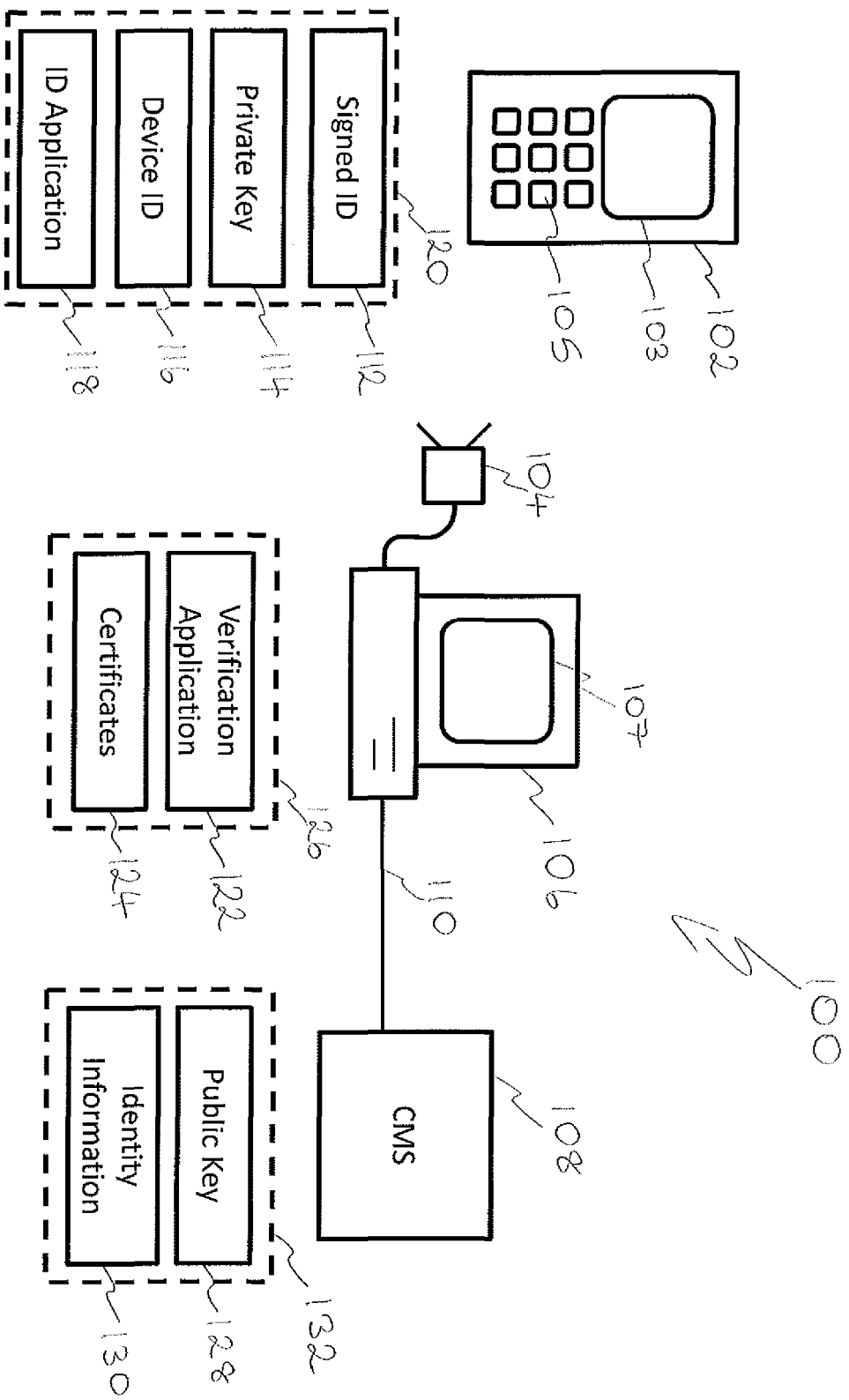
Signed ID
Private Key
Device ID
ID Application
120
112
114
116
118
102
103
105
104
107
106
110
100
Verification Application
Certificates
126
122
124
CMS
108
Public Key
Identity Information
132
128
130

Figure 1

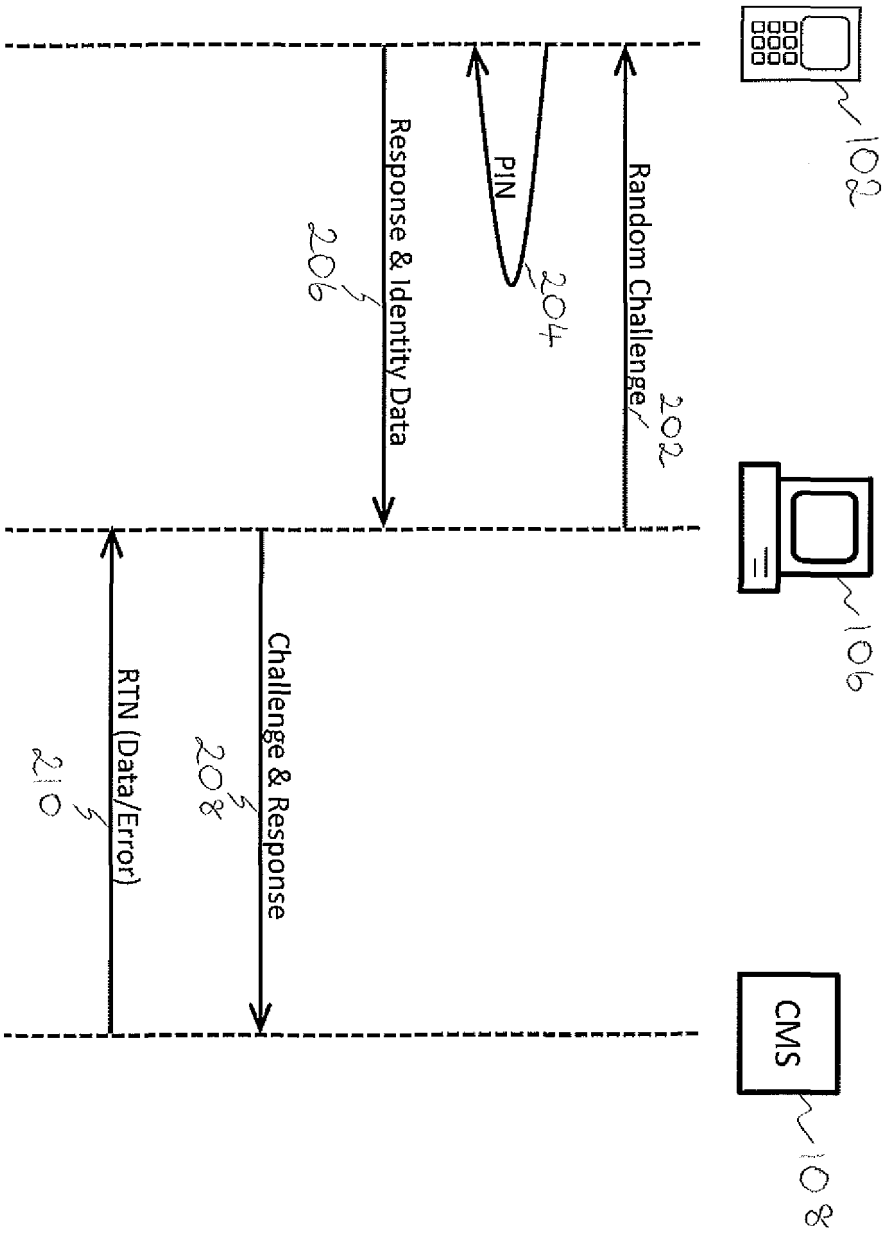
102
PIN
204
Random Challenge
202
Response & Identity Data
206
106
RTN (Data/Error)
210
Challenge & Response
208
CMS
108

Figure 2

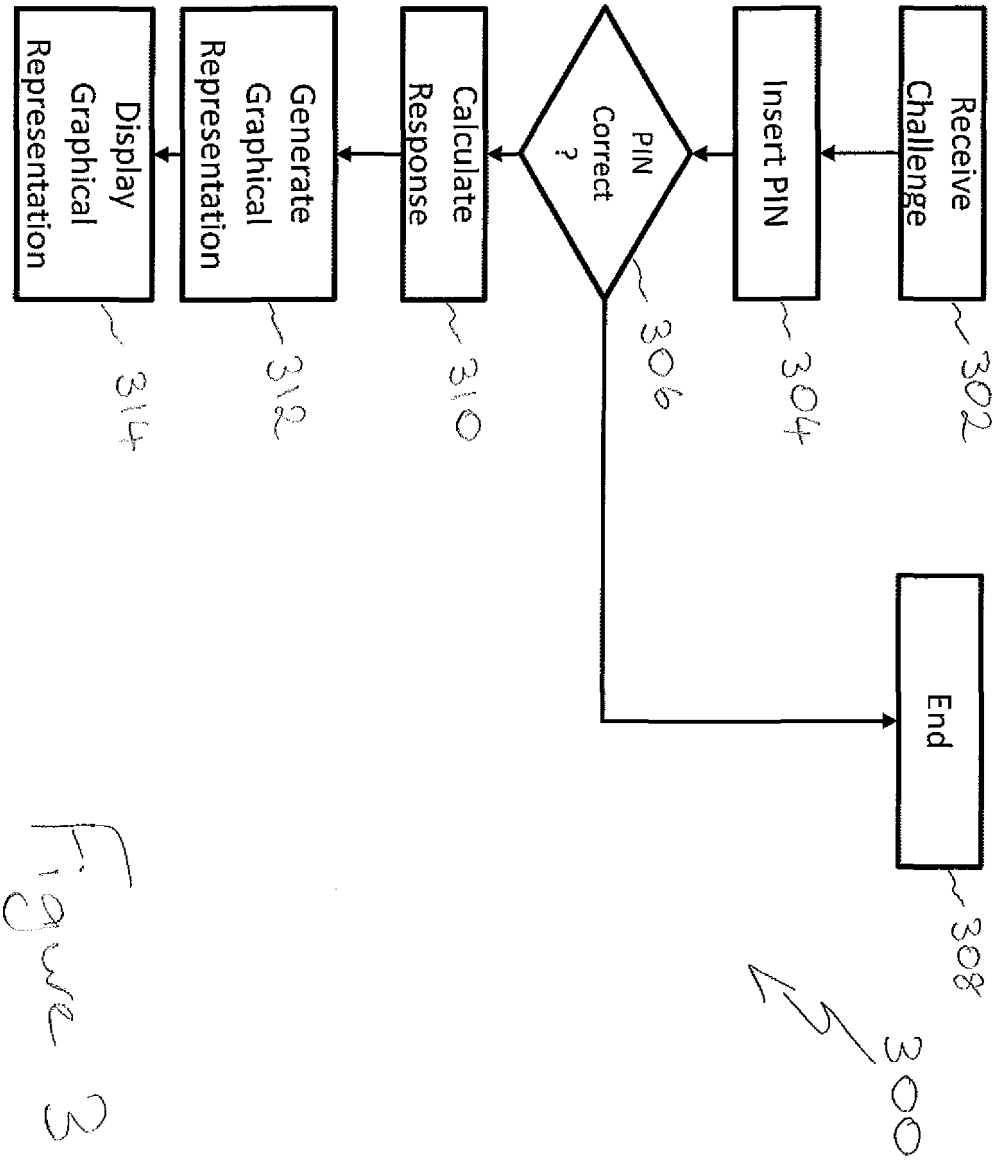
Receive Challenge
302
Insert PIN
304
PIN Correct ?
306
Calculate Response
310
Generate Graphical Representation
312
Display Graphical Representation
314
End
308
300

Figure 3

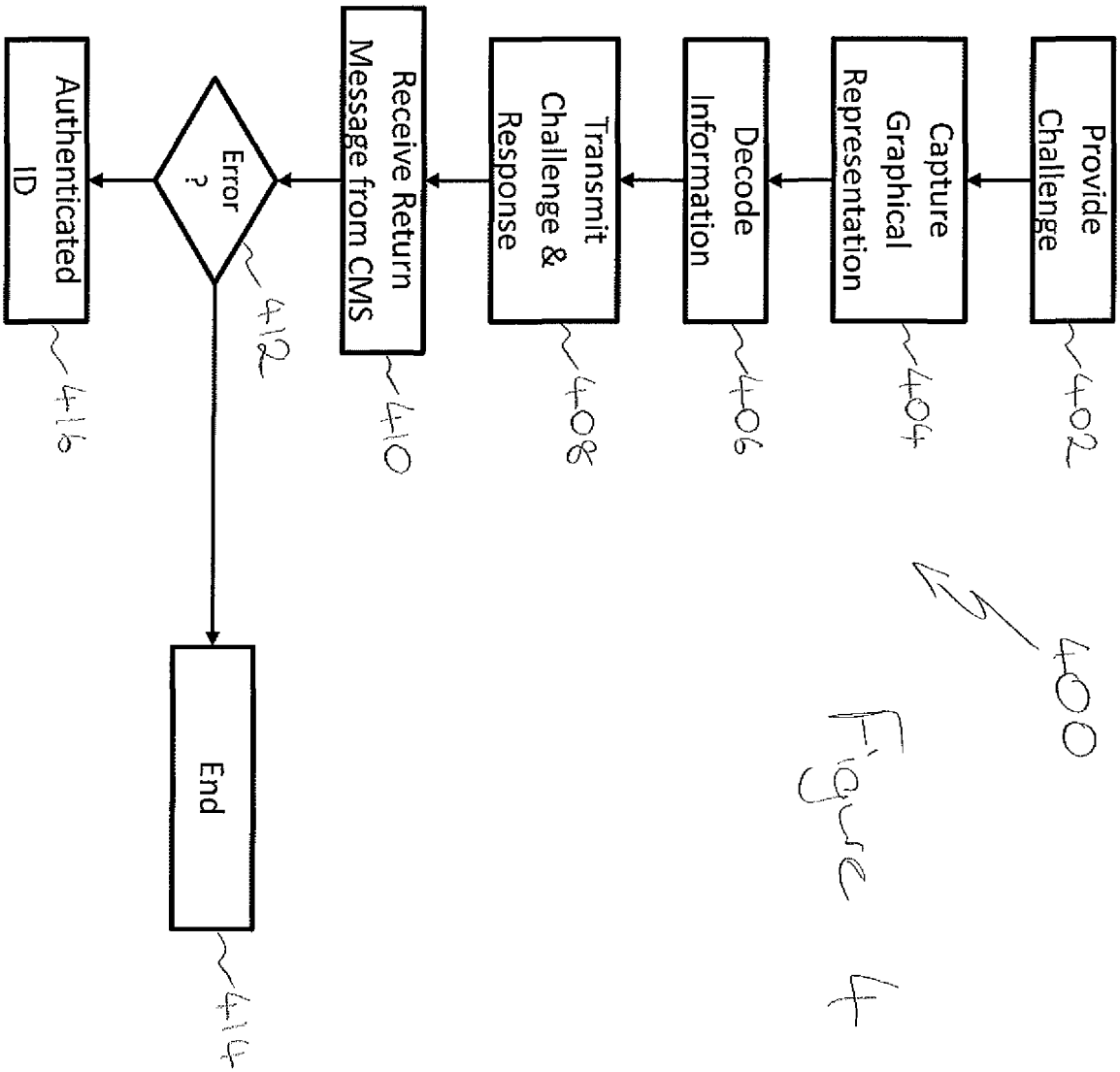
Provide Challenge
402
Capture Graphical Representation
404
Decode Information
406
Transmit Challenge & Response
408
Receive Return Message from CMS
410
Error ?
412
Authenticated ID
416
End
414
400

Figure 4

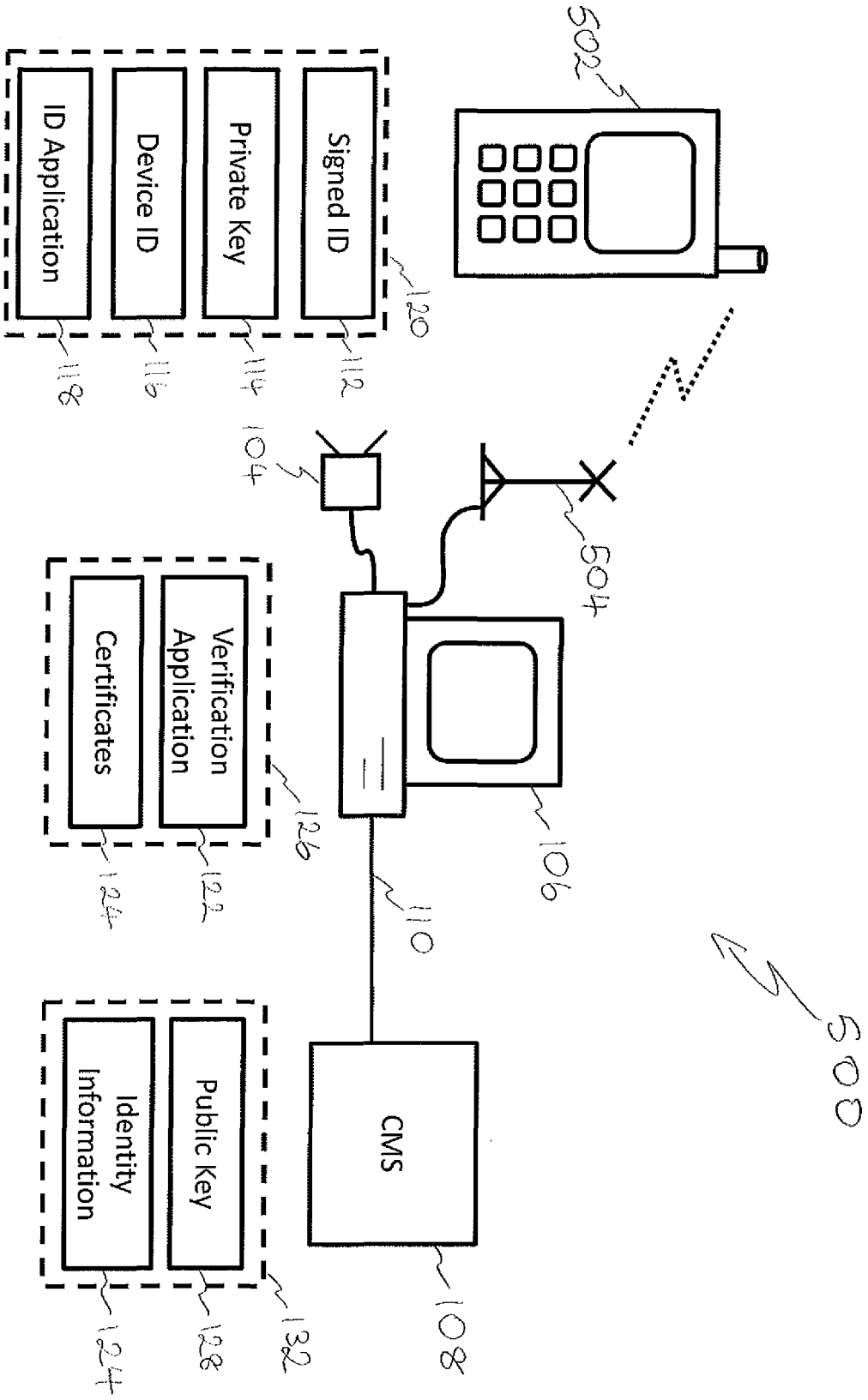
502
Signed ID
Private Key
Device ID
ID Application
120
112
114
116
118
104
504
106
Verification Application
Certificates
126
122
124
110
CMS
Public Key
Identity Information
132
128
124
108
500

Figure 5

IDENTITY VERIFICATION

The present invention relates to methods and devices for providing a verified identity of an entity. In particular, but not exclusively, the present invention relates to methods and devices for providing a verified identity of an entity stored on a mobile device associated with the entity.

BACKGROUND

People are regularly asked to provide information to verify their identity for a range of reasons, from borrowing a library book to staying in a hotel room. Traditionally, to provide verifiable identity information it has been necessary to produce one or more officially issued forms of identification, such as a passport or identity card, generally including at least a photograph of the person, and often other biometrics relating to the person. Often, different service providers will each issue a unique identity card to a user, each identity card only relevant to a particular service provider, and the user may be required to carry a large number of such cards for the various services to which they subscribe.

In recent years, there has been interest in enabling mobile phones to act as 'digital wallets' whereby credit card details may be stored in a secure area of memory on a mobile device and the mobile device used to make payments by wireless communication with a receiver using the NFC (Near Field Communications) standard. This allows payments to be made by simply waving the mobile device over a reader, avoiding the need for the user to physically find and present their credit card.

However, currently there is no standardised way to exchange verified identity information using NFC enabled mobile devices. Furthermore, the number of devices currently available that support the NFC standard is very limited, and the vast majority of mobile devices in use today provide no support at all.

It is an aim of embodiments of the present invention to at least partly mitigate one or more of the aforementioned problems.

It is an aim of certain embodiments of the present invention to enable the provision of verified identity information relating to an entity associated with a mobile device.

It is an aim of some embodiments of the present invention to provide a method of exchanging verified identity information that is applicable to legacy devices that are not compatible with one or more short range wireless communications standards.

BRIEF SUMMARY OF THE INVENTION

According to a first aspect of the invention, there is provided a method of providing verifiable identity information using a mobile device, the method comprising receiving a challenge value, from a guard device, at the mobile device, generating a response value based on the challenge value and a private key associated with the mobile device, and providing the response value and identity information to the guard device.

Providing the response value and the identity information to the guard device may further comprise generating a graphical representation of the response value and the identity information and displaying the graphical representation. The graphical representation may comprise a barcode.

Providing the response value and the identity information may comprise generating a barcode comprising the response value, and displaying the barcode with human readable identification data.

The barcode may comprise a two-dimensional barcode.

Providing the response value and identity information to the guard device may further comprise transmitting the response value and identity information via a network interface.

The network interface may comprise at least one of: an NFC interface, a Bluetooth interface, a Wi-Fi interface, an Ir-DA interface, and a wired interface.

According to some embodiments, the method further comprises requiring entry of a personal identification number to the mobile device by a user of the mobile device before generating the response value.

Receiving the challenge value may comprise receiving a challenge value entered using a keyboard of the mobile device. Alternatively, receiving the challenge value mat comprise decoding an image of a barcode captured from a display of the guard device.

Generating the response value may comprise applying a cryptographic process to the challenge value using the private key and providing the response value and the identity

information to the guard device may further comprise providing a device ID value associated with the mobile device to the guard device.

According to a further aspect of the invention, there is provided a mobile device for providing verifiable identity information, the device comprising input means for inputting challenge information to the mobile device, means for generating a response value based on the challenge value and a private key associated with the mobile device, and means for providing the response value and identity information to a guard device.

The input means may comprise a keyboard for entering the challenge value into the mobile device. Alternatively, the input means may comprise a camera for reading a barcode representation of the challenge value.

The means for providing the response value and the identity information to the guard device may comprise means for generating a graphical representation of the response value and the identity information and means for displaying the graphical representation.

The means for providing the response value and the identity information to the guard device may comprise a network interface. The network interface may comprise at least one of: an NFC interface, a Bluetooth interface, a Wi-Fi interface, an Ir-DA interface, and a wired interface.

According to a further aspect of the invention, there is provided a method of verifying received identity information comprising providing a challenge value to a mobile device, receiving a response value and identity information from the mobile device, transmitting the challenge value and the response value to a credential management system, and receiving an indication of authenticity of the response from the credential management system.

Receiving the response value and identity information may comprise capturing an image of a graphical representation of the response value and the identity information and decoding the graphical representation. The graphical representation may comprise one of: a one-dimensional barcode; a two-dimensional barcode; or a visual datagram.

Receiving the response value and identity information may comprises receiving the response value and identity information using a network interface. The network interface may comprise at least one of: an NFC interface, a Bluetooth interface, a Wi-Fi interface, an Ir-DA interface, and a wired interface.

The received identity information is signed and wherein the method may further comprise verifying the signature against authorised certificates stored in the guard device.

Receiving an indication of authenticity of the response may further comprise receiving a copy of the identity information from the credential management system.

According to a further aspect of the invention, there is provided a guard device for verifying received identity information, the guard device comprising means for providing a challenge value to a mobile device, means for receiving a response value and identity information from the mobile device, means for transmitting the challenge value and the response value to a credential management system, and means for receiving an indication of authenticity of the response from the credential management system.

The means for receiving the response value and identity information may comprise a camera for capturing an image of a graphical representation of the response value and identity information. The graphical representation may comprise one of a one-dimensional barcode, and a two-dimensional barcode.

The means for receiving the response value and identity information may comprise a network interface. The network interface may comprise at least one of: an NFC interface, a Bluetooth interface, a Wi-Fi interface, an Ir-DA interface, and a wired interface.

According to a further aspect of the invention, there is provided a computer program product comprising computer program code configured when executed on a processor to cause a mobile device to perform a method as described above

According to a further aspect of the invention, there is provided a computer program product comprising computer program code configured when executed on a processor to cause a guard device to perform a method as described above.

According to a further aspect of the invention, there is provided a system for verifying identity information associated with an entity, the system comprising the mobile and the guard device, the system further comprising a credential management system configured to store a public key corresponding to the private key associated with the mobile device, the credential management system further configured to apply a cryptographic process to the response value using the public key, and to compare the result of the cryptographic process with the challenge value.

Further advantages of the present invention will be apparent from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention are further described hereinafter by way of example only with reference to the accompanying drawings, in which:

Figure 1 provides an overview illustration of a system according to embodiments of the invention;

Figure 2 is a sequence diagram of data exchange between system entities according to embodiments of the invention;

Figure 3 illustrates a method performed by a mobile device according to embodiments of the invention;

Figure 4 illustrates a method performed by a guard device according to embodiments of the invention; and

Figure 5 provides an overview illustration of a system according to further embodiments of the invention.

DETAILED DESCRIPTION

Figure 1 illustrates a system 100 suitable for implementing embodiments of the invention. The system 100 comprises a mobile device 102, a camera 104, a guard device 106, a credential management system (CMS) 108, and a network connection 110.

The mobile device 102 is associated with an entity of the system, and may for example comprise a mobile telephone owned by a person. The mobile device 102 includes a memory 120 and is pre-provisioned with information 112 that represents the identity of the entity associated with the mobile device 102, and also with a private key 114, of a public/private key pair. The mobile device 102 also stores a unique device ID value 116 that allows the device to be identified, for example an IMEI value associated with the mobile device 102. The mobile device 102 comprises input means 105, such as a keyboard, which may comprise a physical keyboard or one displayed on a touchscreen interface, along with a display screen 103 and includes a processor (not shown) capable of executing an ID application 118 stored in the memory 120 of the device.

The information representing the identity of the entity may itself be cryptographically signed to ensure the integrity of the identity information. According to embodiments, the signing keypair used to sign the identity information may have an associated x.509 digital certificate that can be used to verify the authenticity of the key issuing system.

The mobile device 102 may be any type of mobile device. In particular, although not exclusively, the mobile device 102 may be any of a mobile telephone, a smart phone,

personal digital assistant, tablet computer, or the like. In some embodiments, the mobile device 102 includes a software module or component according to an embodiment of the invention. The software module may be a Java applet which is stored on the mobile device prior to executing a method according to an embodiment of the invention. The software module may be provided as part of the firmware of the mobile device 102 or may be downloaded to the mobile device 102 via a network connection, for example from an application store i.e. a repository of applications.

The guard device 106 is coupled to camera 104 to allow images to be captured by the guard device 106 via the camera 104. The guard device 106 is further coupled to the credential management system 108 via network 110. The guard device 106 typically includes a display screen 107 and input means, and is provided with a verification application 122 stored in a memory 126 on the guard device 106. The guard device 106 may be pre-provisioned with cryptographic data to allow communications between the guard device 106 and the credential management system 108 to be adequately secured.

Although the guard device 106 has been shown in Figure 1 as a desktop computer, it will be recognized that embodiments of the invention are not restricted in this respect. The guard device 106 may be any type of processing device able to execute the verification application 122 and communicate with the client management system 108 via the network 110. For example, the guard device 106 may comprise a computer kiosk (or similar point of sale or access control equipment), or alternatively the guard device could comprise a further mobile device similar to the mobile device 102, but configured to execute a verification application.

In Figure 1, the network connection 110 has been shown as a single entity, for example the Internet. However, it is envisaged that in some embodiments, the network connection 110 will comprise a plurality of communications networks. For example, it is envisaged that the guard device 106 will communicate data with the CMS 108 via one or more computer networks, such as over an IP protocol, and/or via a mobile communication network, such as GPRS, GSM, UMTS, WiMAX, or the like.

The CMS 108 stores a copy of the pre-provisioned identity information 130 relating to the mobile device 102, along with a public key 128 associated with the private key 114 stored on the mobile device 102. The CMS 108 may be configured to store identity and associated key data for a number of mobile devices registered to provide identity information according to embodiments of the invention.

Identity data and the public/private key pair used to verify the identity of the entity must be pre-shared between the mobile device 102 and the CMS 108, preferably but not necessarily

via a trusted or secure channel. For example, registration of a mobile device 102 with the CMS 108 may require that the mobile device and user physically attend a suitable registration office to provide the required identity data for the user entity, and to provision the private key onto the mobile device 102. During such an enrolment, other biometric data relating to the user entity may be captured and stored on the CMS 108, such as a photograph or fingerprint. For less secure applications, it may be possible to provision such data via an encrypted network channel, or some other known method.

Figure 2 illustrates a sequence diagram of a method of providing a verified identity using the mobile device 102 according to an embodiment of the invention. In the method illustrated in Figure 2, the identity verification procedure starts with a random challenge 202 being presented to the mobile device 102 by the guard device 106. The random challenge 202 comprises a short sequence of characters that is displayed on the screen of the guard device 106 and that must be entered into the mobile device 102 by the user via a keyboard or equivalent input means of the mobile device.

The user then enters a personal identification number, or PIN code 204, to the mobile device before the ID application 118 will continue with the verification procedure. The use of the PIN code 204 provides proof of ownership of the device, tying the user to the mobile device 102.

The ID application 118 executing on the mobile device 102 then cryptographically processes the received random challenge 202 using the private key 114 to generate a response value. A graphical representation of information including the response value, the device ID 116 and the identity information 112 of the user entity is then displayed on the screen 103 of the mobile device 102. For example, this graphical representation may comprise a QR-code, barcode, or other visual datagram.

The verification application 122 executing on the guard device 106 captures the displayed graphical representation 206 using the camera 104, and proceeds to decode the information contained within the graphical representation. Thus, the guard device 106 obtains from the mobile device 102: signed ID information 112 relating to the user entity; a device ID 116; and the response value generated using the private key 114 stored on the mobile device 102.

The guard device 106 transmits the random challenge value along with the response over network connection 110 to the credential management system 108 in message 208.

The CMS 108 has stored in memory 132 the public key 128 corresponding to the private key 114 of the mobile device. Thus, the CMS 108 is able to apply an inverse cryptographic algorithm to the response value using this public key 128 to recover the challenge 202. If the

challenge value is successfully recovered from the response value, then the response value must have been generated using the private key 114, and therefore the identity of the mobile device 102 is verified, and the CMS 108 returns an indication of successful authentication to the guard device 106. However, if the correct challenge value is not recovered, then the identity of the mobile device cannot be authenticated and an error value is returned to the guard device 106.

According to some embodiments, the CMS 108 may supply further identity information to the guard device 106 upon a successful authentication of the mobile device 102. For example, the CMS 108 may return a copy of the signed entity identity data identical to the ID information 112 stored on the mobile device 102. Optionally, further information may be supplied such as a photograph of the user, or other biometric information, to allow a further check of identity to be made by the guard operating the guard device 106.

Figure 3 illustrates a method 300 performed by an identity application 118 executing on the mobile device 102 according to an embodiment of the invention. As shown in Figure 3, the method 300 comprises receiving a random challenge value at step 302, and then receiving a PIN value from a user of the device at step 304. The PIN value that has been input in step 304 is then checked in step 306. If an incorrect PIN number is input the method ends at step 308, however if the PIN number is correct the method continues at step 310 with the cryptographic processing of the challenge received challenge value using the private key 114 stored on the mobile device to determine a response value. At step 312 a graphical representation of the Signed ID information 112, the Device ID 116 and the response value is generated, for example in the form of a two-dimensional barcode. This graphical representation is then display on a screen of the mobile device 102 at step 314, to allow the information to be read by the guard device 106 using the camera 104.

Figure 4 illustrates a method 400 performed by the verification application 122 executing on the guard device 106 according to an embodiment of the invention. At step 402, the method begins by the guard device 106 providing a random challenge value to be input into the mobile device 102. As described above, the random challenge comprises a short sequence of characters. The guard device 106 then captures the graphical representation of information, generated in response to the challenge value by the mobile device 102, using the camera 14 at step 404. The information held by the graphical representation is then decoded at step 406 to recover the signed ID information 112 relating to the user entity associated with the device, the device ID 116 of the mobile device 102 and a response value based on the challenge and the private key 114 stored on the mobile device 102.

Having recovered the information from the graphical representation, the verification application 122 transmits the challenge value, along with the response value received from the mobile device, to the CMS 108 via network connection 110. The challenge and response values are processed by the CMS 108 and a return message is received by the verification application at step 410. The verification application 122 then determines whether the return message indicates an error, or exception, indicating that authentication of the mobile device 102 by the CMS 108 has failed at step 412, and if so the method ends at step 414. However, if an error is not indicated in the return message from the CMS 108, the authentication of the mobile device 102 and therefore the verification of the identity of the user entity is completed in step 416.

Upon successful verification of the user entity's identity, the guard device will display the entity identity information present in the signed ID 112 information provided by the mobile device 102. The displayed information will therefore provide an operator of the guard device 106 with a verified identity for the user presenting the mobile device 102.

According to embodiments, the CMS 108 may return further identification information to the guard station 106 upon successful authentication of the mobile device 102. For example, the CMS 108 may provide a stored digital photograph of the user associated with the mobile device to the guard station 106 to allow a guard to perform a further visual identification of the user of the mobile device. Other biometric data could also be provided, such as fingerprint information, depending upon the level of authentication required.

According to some embodiments, the guard device 106 is pre-provisioned with authorised certificates that can be used to verify whether the signature of the signed ID 112 information has been issued by a trusted issuer, such that trust in the data integrity of the signed ID 112 (and the signature itself) depends from a trusted root certificate, for example in accordance with the X.509 standard. Thus, according to this embodiment, the guard device 106 is able to verify the identity information 112 without communication with the CMS 108.

Optionally, the verification application 122 executing on the guard device 106, having verified the signature of the signed ID information, may continue to forwarding the challenge and response information to the CMS 108 for further checking. If the signature cannot be verified against the authorised certificates, the verification application 122 may determine that the entity identity information provided is suspicious and terminate the verification procedure immediately, avoiding unnecessary use of network resources.

According to further embodiments, the guard device 106 may receive a public key associated with the mobile device 102. The public key value can then be used to verify the

response and/or the integrity of the identity data. The public key may be provided by the CMS 108, or alternatively the public key could be received from an unsecure source, including the mobile device 102 itself, and then through communication between the guard device 106 and the CMS 108 the authenticity of the public key as being associated with the mobile device 102 can be determined.

The above described embodiments have been described as using a graphical representation such as a two-dimensional barcode to transfer data from the mobile device 102 to the guard device 106 via the camera 104. It will be understood that such graphical representations are not limited to two-dimensional barcodes, but could comprise one or more of a one-dimensional barcode, two dimensional barcode, human readable text read into the guard device using optical character recognition (OCR), or the like. For example, some or all of the identity information could be displayed in human readable form on the mobile device 102 and read into the guard device 106 using OCR, while any remaining information is made available in barcode format.

Similarly, while in the described embodiment the random challenge value is input to the mobile device 102 using a keyboard or similar input device, it will be recognized that the random challenge value could be encoded into a graphical representation displayed on a screen of the guard device and read by the mobile device using a camera provided with the mobile device 102.

According to some embodiments of the invention, the identification information 112 stored on the mobile device need not be signed to ensure it is reproduced authentically. In this embodiment, identification information provided by the CMS 108 is displayed on the guard device 106 as the CMS 108 is considered a trusted source for identity information.

Alternatively, the guard device 106 may receive unsigned identification information from the mobile device and generate a hash value of the identification data using a cryptographic hash algorithm. This hash value is then transmitted to the CMS 108 over the network 110, along with the challenge and response information. As the identity information stored at the CMS 108 should be identical to that provided by the mobile device 102, the CMS is able to determine whether the hash value has been generated from correct identity information and thereby verify the unsigned identity information received by the guard device 106.

Figure 5 illustrates a further embodiment of the invention, similar in operation to the embodiments described above, but which does not rely on a graphical representation of the response and identification data. In the embodiment of Figure 5, mobile device 502 and guard device 106 are provided with an alternative communication interface, for example the

devices may be able to communicate using one or more of the Near Field Communication (NFC), Bluetooth, WiFi, and infrared data association (IrDA) standards or via a wired connection. Transfer of data between the mobile device and the guard device can therefore be accomplished over the alternative interface, and it is not necessary to generate a graphical representation of the data.

Thus, according to the embodiment of Figure 5, the mobile device 502 generates a response value by cryptographically processing the challenge value using the private key 114, as before, and then transmits the response value along with the signed identification information 112 to an interface 504, such as a wireless interface, of the guard device 106. The identity verification process then proceeds as described above.

The embodiment of Figure 5 may facilitate quicker implementation of the method, at the expense of requiring increased functionality to be provided by the mobile device 102. It is envisaged that in some embodiments guard devices 106 may be implemented with various interface types, as well as with a camera, to allow the guard device 106 to implement both graphical and alternative methods of data exchange according to the abilities of the mobile device 102.

It will be appreciated that embodiments of the present invention can be realised in the form of hardware, software or a combination of hardware and software. Any such software may be stored in the form of volatile or non-volatile storage such as, for example, a storage device like a ROM, whether erasable or rewritable or not, or in the form of memory such as, for example, RAM, memory chips, device or integrated circuits or on an optically or magnetically readable medium such as, for example, a CD, DVD, magnetic disk or magnetic tape. It will be appreciated that the storage devices and storage media are embodiments of machine-readable storage that are suitable for storing a program or programs that, when executed, implement embodiments of the present invention. Accordingly, embodiments provide a program comprising code for implementing a system or method as claimed in any preceding claim and a machine readable storage storing such a program. Still further, embodiments of the present invention may be conveyed electronically via any medium such as a communication signal carried over a wired or wireless connection and embodiments suitably encompass the same.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of any foregoing embodiments. The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed. The claims should not be construed to cover merely the foregoing embodiments, but also any embodiments which fall within the scope of the claims.

Claims:

1. A method of providing verifiable identity information using a mobile device, the method comprising:

receiving a challenge value, from a guard device, at the mobile device;

generating a response value based on the challenge value and a private key associated with the mobile device; and

providing the response value and identity information to the guard device.

2. The method of claim 1, wherein providing the response value and the identity information to the guard device further comprises generating a graphical representation of the response value and the identity information and displaying the graphical representation.

3. The method of claim 2, wherein the graphical representation comprises a barcode.

4. The method of claim 2, wherein providing the response value and the identity information comprises generating a barcode comprising the response value, and displaying the barcode with human readable identification data.

5. The method of claim 3 or claim 4, wherein the barcode comprises a two-dimensional barcode.

6. The method of claim 1, wherein providing the response value and identity information to the guard device further comprises transmitting the response value and identity information via a network interface.

7. The method of claim 6, wherein the network interface comprises at least one of: an NFC interface, a Bluetooth interface, a Wi-Fi interface, an Ir-DA interface, and a wired interface.

8. The method of any preceding claim further comprising requiring entry of a personal identification number to the mobile device by a user of the mobile device before generating the response value.

9. The method of any preceding claim, wherein receiving the challenge value comprises receiving a challenge value entered using a keyboard of the mobile device.

10. The method of any preceding claim, wherein receiving the challenge value comprises decoding an image of a barcode captured from a display of the guard device.

11. The method of any preceding claim, wherein generating the response value comprises applying a cryptographic process to the challenge value using the private key.

12. The method of any preceding claim, wherein providing the response value and the identity information to the guard device further comprises providing a device ID value associated with the mobile device to the guard device.

13. A mobile device for providing verifiable identity information, the device comprising:

input means for inputting challenge information to the mobile device;

means for generating a response value based on the challenge value and a private key associated with the mobile device; and

means for providing the response value and identity information to a guard device.

14. The mobile device of claim 13, wherein the input means comprises a keyboard for entering the challenge value into the mobile device.

15. The mobile device of claim 13, wherein the input means comprises a camera for reading a barcode representation of the challenge value.

16. The mobile device of any of claims 13 to 15, wherein the means for providing the response value and the identity information to the guard device comprise means for

generating a graphical representation of the response value and the identity information and means for displaying the graphical representation.

17. The mobile device of any of claims 13 to 15, wherein the means for providing the response value and the identity information to the guard device comprise a network interface.

18. The mobile device of claim 17, wherein the network interface comprises at least one of: an NFC interface, a Bluetooth interface, a Wi-Fi interface, an Ir-DA interface, and a wired interface.

19. A method of verifying received identity information comprising:

providing a challenge value to a mobile device;

receiving a response value and identity information from the mobile device;

transmitting the challenge value and the response value to a credential management system; and

receiving an indication of authenticity of the response from the credential management system.

20. The method of claim 19, wherein receiving the response value and identity information comprises capturing an image of a graphical representation of the response value and the identity information and decoding the graphical representation.

21. The method of claim 20, wherein the graphical representation comprises one of: a one-dimensional barcode; a two-dimensional barcode; or a visual datagram.

22. The method of claim 19, wherein receiving the response value and identity information comprises receiving the response value and identity information using a network interface.

23. The method of claim 22, wherein the network interface comprises at least one of: an NFC interface, a Bluetooth interface, a Wi-Fi interface, an Ir-DA interface, and a wired interface.

24. The method of any of claims 19 to 23, wherein the received identity information is signed and wherein the method further comprises verifying the signature against authorised certificates stored in the guard device.

25. The method of any of claims 19 to 24, wherein receiving an indication of authenticity of the response further comprises receiving a copy of the identity information from the credential management system.

26. A guard device for verifying received identity information, the guard device comprising:

means for providing a challenge value to a mobile device;

means for receiving a response value and identity information from the mobile device;

means for transmitting the challenge value and the response value to a credential management system; and

means for receiving an indication of authenticity of the response from the credential management system.

27. The guard device of claim 26, wherein the means for receiving the response value and identity information comprise a camera for capturing an image of a graphical representation of the response value and identity information.

28. The guard device of claim 27, wherein the graphical representation comprises one of a one-dimensional barcode, and a two-dimensional barcode.

29. The guard device of claim 26, wherein the means for receiving the response value and identity information comprise a network interface.

30. The guard device of claim 29, wherein the network interface comprises at least one of: an NFC interface, a Bluetooth interface, a Wi-Fi interface, an Ir-DA interface, and a wired interface.

31. A computer program product comprising computer program code configured when executed on a processor to cause a mobile device to perform the method of any of claims 1 to 12.

32. A computer program product comprising computer program code configured when executed on a processor to cause a guard device to perform the method of any of claims 19 to 25.

33. A system for verifying identity information associated with an entity, the system comprising a mobile device according to any of claims 13 to 18 and a guard device according to any of claims 26 to 30, the system further comprising:

a credential management system configured to store a public key corresponding to the private key associated with the mobile device;

the credential management system further configured to apply a cryptographic process to the response value using the public key, and to compare the result of the cryptographic process with the challenge value.

34. A method substantially as described hereinbefore with reference to the accompanying drawings.

35. A mobile device or guard device substantially as described hereinbefore with reference to the accompanying drawings.

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Claims searched:	1 to 35	**Date of search:**	30 January 2012

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-33	US7992776 B1 (Ramachandran et al.) See abstract, column 21 line 4-column 23 line 19
X	1-33	US2004/0225613 A1 (Narayanaswami et al.) See abstract, paragraphs 42-74
X,Y	X: 1, 6, 7, 9, 11-14, 17, 18, 19, 22-26, 29-33; Y: 2-5, 10, 15, 16, 20, 21, 27, 28	WO2002/095689 A1 (Ericsson) See abstract, page 4 lines 11-17, page 5 lines 5-7, page 10 line 21-page 12 line 23, page 16 lines 13-14
X,Y	X: 1, 6, 7, 9, 11-14, 17, 18, 19, 22-26, 29-33; Y: 2-5, 10, 15, 16, 20, 21, 27, 28	WO00/58920 A1 (Vitanen) See abstract, page 6 line 23-page 7 line 23
X,Y	X: 1, 6, 7, 9, 11-14, 17, 18, 19, 22-26, 29-33; Y: 2-5, 10, 15, 16, 20, 21, 27, 28	EP1898349 A1 (Siemens) See abstract, paragraphs 60-61 and 64
X,Y	X: 1, 6, 7, 9, 11-14, 17, 18,	US2008/0268815 A1 (Jazra et al.) See abstract, paragraphs 29-33

	19, 22-26, 29-33; Y: 2-5, 10, 15, 16, 20, 21, 27, 28	
X,Y	X: 1, 6, 7, 9, 11-14, 17, 18, 19, 22-26, 29-33; Y: 2-5, 10, 15, 16, 20, 21, 27, 28	US2003/0055738 A1 (Alie) See abstract, paragraphs 78-80, 82, 95 and 99
Y	2-5, 10, 15, 16, 20, 21, 27, 28	US2011/0208659 A1 (Easterly et al.) See abstract, paragraph 2
Y	2-5, 10, 15, 16, 20, 21, 27, 28	GB2478753 A (Adamson) See abstract
Y	2-5, 10, 15, 16, 20, 21, 27, 28	US2010/0012715 A1 (Williams et al.) See abstract
Y	2-5, 10, 15, 16, 20, 21, 27, 28	EP1650894 A1 (NEC) See abstract
Y	2-5, 10, 15, 16, 20, 21, 27, 28	DE10005487 A (Siemens) See abstract
Y	2-5, 10, 15, 16, 20, 21, 27, 28	TW201107577 A1 (Xian-Tang) See abstract

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[X] :

Worldwide search of patent documents classified in the following areas of the IPC

G06Q; H04L; H04W

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
H04L	0009/32	01/01/2006
H04L	0029/06	01/01/2006