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(54) URL-BASED CERTIFICATE IN A PKI

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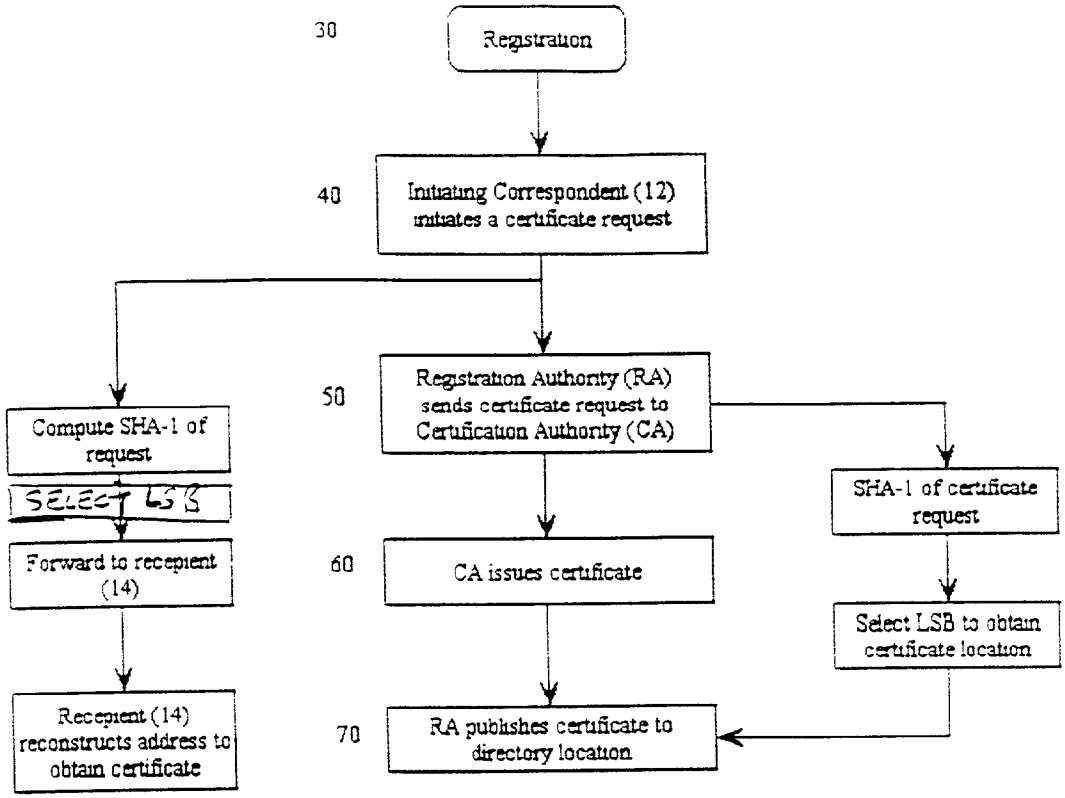
(57) **ABSTRACT**

A method of requesting and issuing a certificate from certification authority for use by an initiating correspondent with a registration authority is provided. The initiating correspondent makes a request for a certificate to the registration authority, and the registration authority sends the request to a certificate authority, which issues the certificate to the registration authority. The certificate is stored at a location in a directory and this location is associated with a pointer such as uniform resource locator (URN) that is derived from information contained in the certificate request. The initiating correspondent computes the location using the same information and forwards it to other correspondents. The other correspondents can then locate the certificate to authenticate the public key of the initiating correspondent.



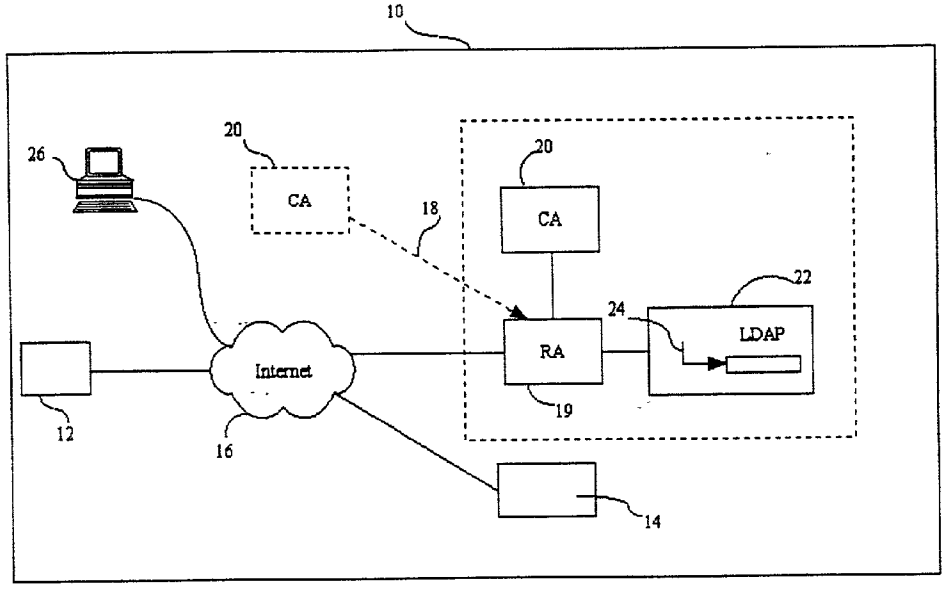


Fig. 1

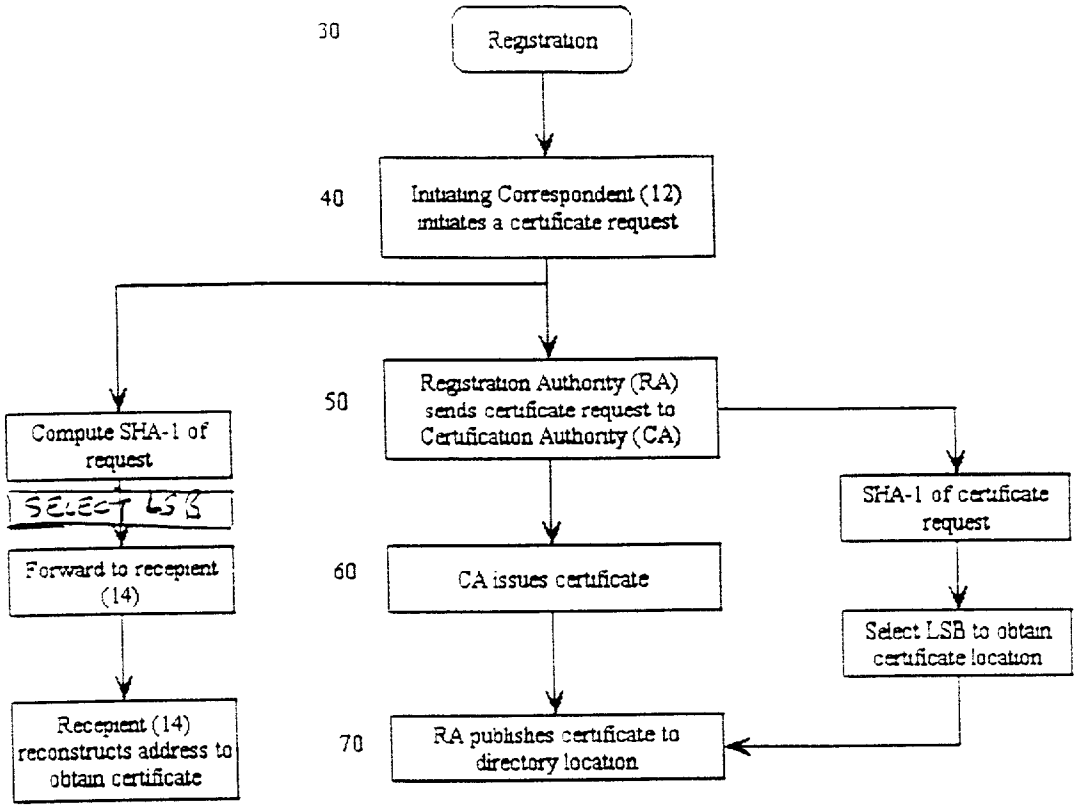

30
Registration
40
Initiating Correspondent (12) initiates a certificate request
50
Registration Authority (RA) sends certificate request to Certification Authority (CA)
Compute SHA-1 of request
SELECT LSB
Forward to recepient (14)
Recepient (14) reconstructs address to obtain certificate
60
CA issues certificate
70
RA publishes certificate to directory location
SHA-1 of certificate request
Select LSB to obtain certificate location

Fig. 2

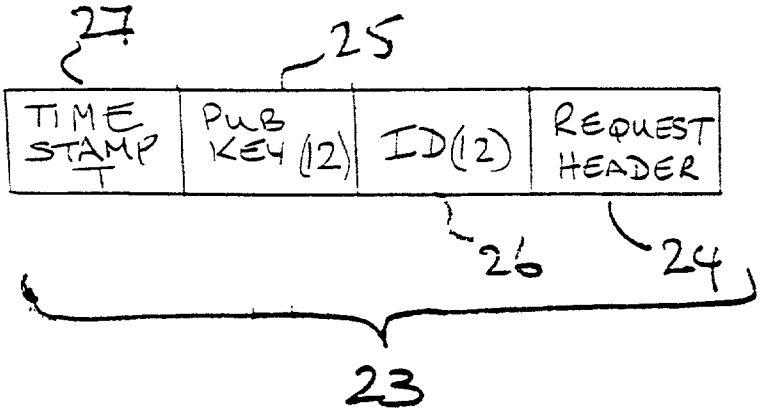

27
25
TIME STAMP
PUB KEY (12)
ID(12)
REQUEST HEADER
26
24
23

FIG 3

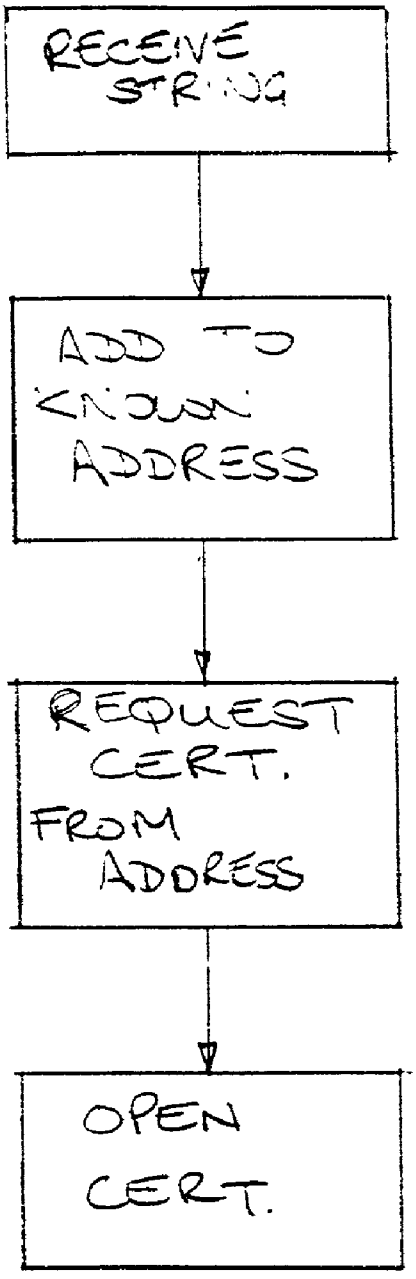

RECEIVE STRING
ADD TO KNOWN ADDRESS
REQUEST CERT. FROM ADDRESS
OPEN CERT.

FIG. 4

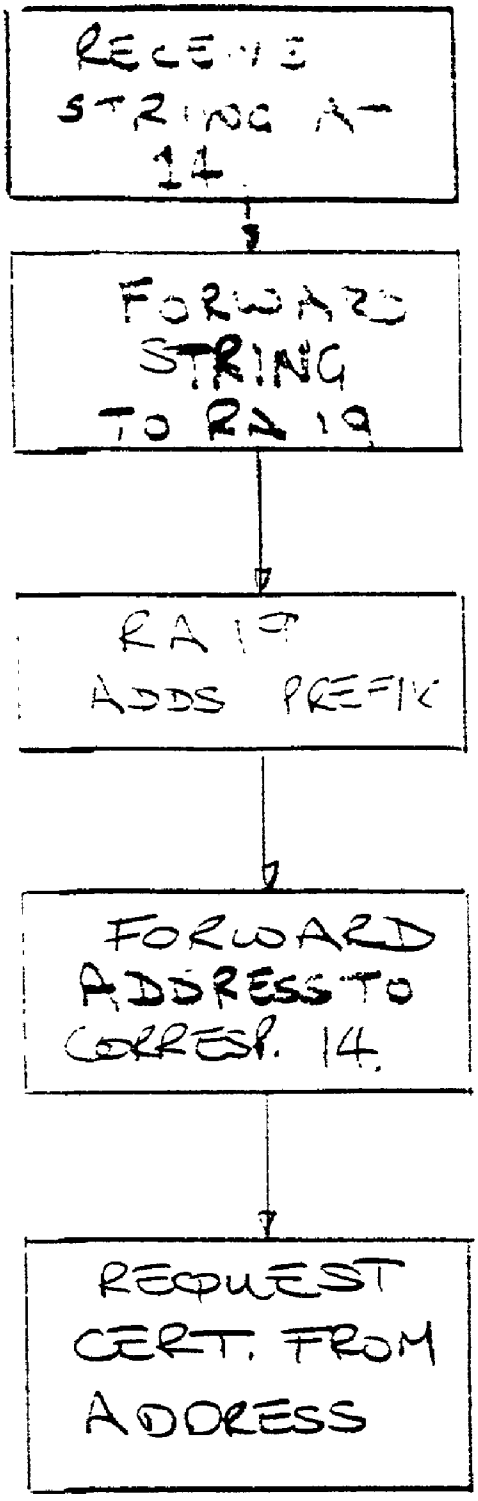

RECEIVE STRING AT 14
FORWARD STRING TO RA 19
RA 19 ADDS PREFIX
FORWARD ADDRESS TO CORRESP. 14
REQUEST CERT. FROM ADDRESS

FIG 5.

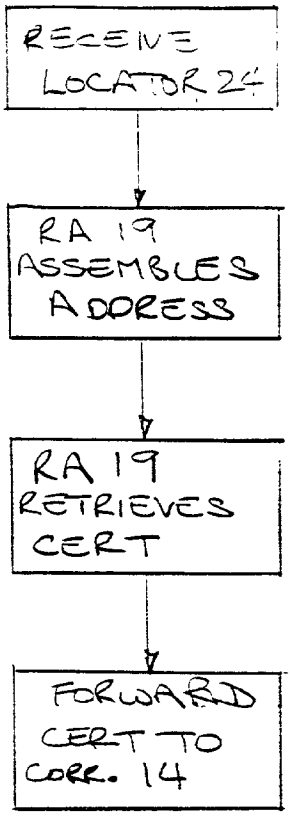

RECEIVE LOCATOR 24
RA 19 ASSEMBLES ADDRESS
RA 19 RETRIEVES CERT
FORWARD CERT TO CORR. 14

FIG 6.

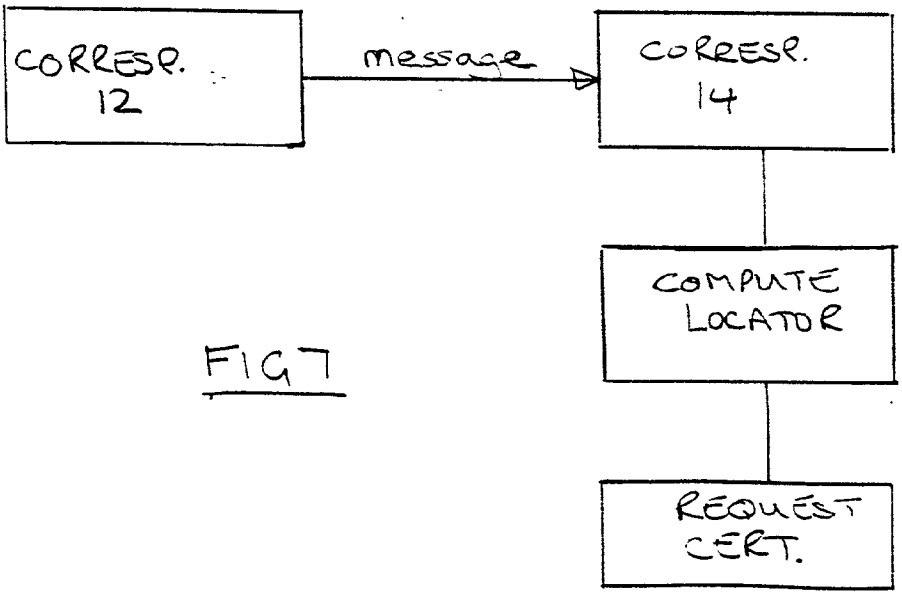

CORRESP. 12
message
CORRESP. 14
COMPUTE LOCATOR
REQUEST CERT.

FIG 7

URL-BASED CERTIFICATE IN A PKI

FIELD OF THE INVENTION

[0001] The present invention relates to a field of cryptography, in particular to the issuance of certificates to mobile clients in a (Public Key Infrastructure).

BACKGROUND OF THE INVENTION

[0002] Electronic commerce is hampered by privacy and security, as there is a requirement to ensure that the sender of an electronic transmission is in fact who they purport to be. Due to the non-physical nature of the medium, traditional methods of physically marking the media with a seal or signature, for various business and legal purposes, are not practical. Rather, some mark must be coded into the information itself in order to identify the source, authenticate the contents, and provide privacy against eavesdroppers.

[0003] Public key cryptography is the basis for a number of popular digital signature and key management schemes. These include Diffie-Hellman key agreement and the RSA, DSA, and ECDSA digital signature algorithms. Public key algorithms are typically combined with other cryptographic algorithms (e.g. DES) and security protocols (e.g. SSL) to provide a wide range of sophisticated and scalable security services such as authentication, confidentiality, and integrity.

[0004] Public key cryptography uses a pair of cryptographic keys—one private and one public. Public key cryptography provides an elegant architecture for authentication and authorization, on any kind of communication channel. The Private key is kept secret and used to create digital signatures and decrypt encrypted messages. The public key of the user can be published and used by others to confirm the validity of a digital signature or to encrypt a message to the owner of the corresponding private key.

[0005] A public-key certificate binds a public-key value to a set of information that identifies an entity (such as a person, organization, account or site) associated with use of the corresponding private key.

[0006] In order to permit one correspondent to communicate securely with another it is necessary that each is confident of the authenticity of the other and that the public key used by are of the correspondents to verify signatures or decrypt messages is in fact the public key of the other correspondent. This is typically achieved through the use of a certificate issued by a party trusted by both correspondents. The initiating correspondent requests the trusted party to sign the public key with the trusted parties own private key and thereby create a certificate.

[0007] The certificate may then be forwarded to the recipient correspondent who has the trusted parties public key. The recipient can therefore verify the initiating correspondent's public key and proceed with a communication.

[0008] The trusted party is usually a certifying authority or CA and the CA's public key will be embedded in or provided to the correspondents devices when they subscribe to the infrastructure organized by the CA. There is therefore a high degree of confidence that the CA's public key is accurate and genuine.

[0009] Usually a CA is responsible for several tasks. These may include, without restriction:

[0010] Receiving certificate requests;

[0011] Validating that the requesting entity has control of the private key matching the requested public key (proof of possession);

[0012] Validating the conformance of the request with local policy, including restrictions on identifying information, attribute information and/or keying material;

[0013] Modifying the request to create conformance with local policy;

[0014] Validating the information in the request against external data sources;

[0015] Determining if the request has been authenticated by the user or some other authority;

[0016] Presenting the request for manual approval by an administrator or administrators;

[0017] Signing or authenticating the certificate;

[0018] Publishing the certificate to a central storage point or multiple storage points; and

[0019] Returning the certificate to the requestor

[0020] The infrastructure organized under the CA is known as a public key infrastructure (PKI) and commonly defined as a set of hardware, software, people, policies and procedures needed to create, manage, store, distribute, revoke and destroy certificates and keys based on public key cryptography, in a distributed computing system. A PKI may include a certificate issuing and management system (CIMS) whereby includes the components of the PKI that are responsible for the issuance, revocation and overall management of the certificates and certificate status information. A CIMS includes a CA and may include Registration Authorities (RAs), and other subcomponents.

[0021] The advent of new technologies, such as 2.5G and 3G networks, which provide enough bandwidth to support audio and video content, and seamless global roaming for voice and data has given rise to a new class of mobile devices such as network-connected personal digital assistants (PDAs) and WAP-enabled mobile phones generally referred to as constrained devices. This trend effectively extends traditional personal computer application services to mobile devices, such that traditional e-commerce is performed on mobile devices, that is, mobile commerce. As in e-commerce there is still a need for the client to provide identification, authentication and authorization to the merchant, authentication being the act of verifying the claimed identity of the station or originator, while authentication involves the use of certificates via a certification authority.

[0022] However, there exists a problem with the current methods for obtaining mobile certificates from a certification authority due to bandwidth constraints, network latency, and the limitations of the resources of the mobile device such as processor power, speed and memory storage. Certificates are characteristically large pieces of data such that transmission times between the mobile device and the certification

authority, or between a pair of mobile devices, may lead to substantial bandwidth usage during transactions and raise issues with data integrity.

[0023] It has previously been proposed to reduce the bandwidth in the exchange of such certificates by storing the certificates at a server and allocating an identifier to the stored location. The initiating client may then receive the URN, or other location indicator, of the certificate, which can then be forwarded to the other correspondent. The other correspondent may then retrieve the certificate and verify the information provided. This arrangement reduces the bandwidth needed compared with transmitting a full certificate but does not reduce the number of messages transmitted between the client and the RA or CA, and thus does not affect the significant network latency burden that results, especially when hundreds or thousands of certificate requests per minute may be handled by the CA.

[0024] Accordingly, it is an object of the present invention to obviate mitigate at least one of the above disadvantages.

SUMMARY OF THE INVENTION

[0025] In accordance with one of its aspects, the invention provides a method of allocating an address to a certificate to be stored in an addressable database for subsequent retrieval, by combining information obtained from a request for a certificate with information known to a party retrieving said certificate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] Preferred embodiments of the invention will now be described by way of example only with reference is made to the appended drawings wherein:

[0027] **FIG. 1** shows a block diagram of a system for transactions between correspondents in a PKI;

[0028] **FIG. 2** shows a flow chart outlining the steps for providing a certificate from one correspondent to another;

[0029] **FIG. 3** is a representation of a certificate request;

[0030] **FIG. 4** is a flow chart outlining the steps utilised to determine a certificate address.

[0031] **FIG. 5** is a flow chart similar to **FIG. 4** of an alternative embodiment for determining the certificate address;

[0032] **FIG. 6** is a flow chart similar to **FIG. 4** of a further alternative embodiment for determining the certificate address; and

[0033] **FIG. 7** is a flow chart showing an alternative embodiment to that shown in **FIG. 2**.

DESCRPTION OF THE PREFERRED EMBODIMENT

[0034] Reference is first made to **FIG. 1**, showing as a block diagram a data communication system **10** for substantially secure transactions between a pair of correspondents **12** and **14**. In the embodiment shown in **FIG. 1**, the initiating correspondent **12** is shown as a client side wireless device such as a cellular phone, pager or PDA. The initiating correspondent **12** is communicatively coupled to the recipient correspondent **14** via a communication network **16**, typically embodied as the Internet.

[0035] Secure communications between the correspondents **12** and **14** may be implemented by providing a public key infrastructure (PKI) **18** to the network **16**. The PKI **18** includes a registration authority (RA) **19** to receive and process requests for a certificate from correspondent **12** and one or more certification authorities (CA) **20**. The PKI **18** provides a standards-based certificate issuance and management system (CIMS) platform for issuing, publishing and revoking public key certificates. Each of the correspondents **12, 14** have the public key of the (CA) **20** embedded in the devices so as to be able to verify messages sent by the (CA) **20** and signed with the corresponding private key or the (CA) **20**.

[0036] The registration authority **19** has three major roles in the PKI **18**:

[0037] Firstly, the registration authority **19** handles the Registration Authority (RA) functions in the PKI, e.g., registers users, and approves or denies requests made by correspondents**12, 14**, such as requests for first-time certificates and renewal of expired certificates, etc.

[0038] Secondly, because of the multiple devices that may be used, and the need for various parties in the network to communicate in accordance with standard protocols, the registration authority **19** translates and relays access protocols/message formats on behalf of PKI enabled clients. The registration authority **19** is typically a networked server responsible for translating protocol requests, and relaying back protocol responses, between PKI clients **12** and the CA **20**. The functions to be performed by each of the correspondents **12, 14**, the RA **19** and CA **20** are implemented through executable commands embodied in software installed on each of the devices. The software may be supplied on a computer readable medium for installation on respective areas of the devices or may be supplied directly over the network to each of the devices.

[0039] For example, in a typical application, WPKI requests from wireless correspondent **12** are converted to Certificate Management Protocol (CMP) requests for the CA **20**. Likewise, the registration authority **19** on behalf of the wireless correspondent **12** via a secure WTLS session processes responses from the CA. Similarly, requests from desktop clients **26** using a CMP protocol are approved (or denied) and relayed to the CA **20**. The registration authority **19** similarly relays responses from the CA **20** to the desktop client **26**.

[0040] Thirdly, the registration authority **19** processes and schedules client certificate requests in accordance with the registration policies of the particular PKI in which it is used. As part of this process the registration authority **19** can access database/directories to manage state information.

[0041] The CA **20** issues the certificate through the registration authority **19** for use by the correspondent **12** and posts information about the certificate to a directory **22** that

can be accessed by other correspondents **14** either directly or through the RA **19**. Essentially the certificate is a message incorporating the public key of the correspondent **12** and the identity of the correspondent **12** that is signed by the private key of the CA **20**. Each of the correspondents **12**, **14** has the public key of the CA **20** embedded and so can verify the CA's signature on the certificates issued by the CA **20**.

[**0042**] As an overview of the operation, therefore, the correspondent **12** who wishes to conduct a secure transaction with the correspondent **14** initially applies to the registration authority **19** for a certificate. The registration authority **19** processes the request in accordance with predetermined criteria and either rejects the request or, if approved, passes it to the CA **20**. The CA **20** processes the request according to specific procedures and issues a certificate to the registration authority **19**. The CA **20** or RA **19** posts the certificate to the directory **22** at a predetermined address indicated by a certificate locator **24** for subsequent use as will be described in further detail below.

[**0043**] The certificate locator **24** is also available to correspondent **12**, as will be described below, who initiates in the transaction with the correspondent **14** by forwarding a data package which includes a message signed with the private key of correspondent **12** whose corresponding public key has been certified by the CA **20** and the certificate locator **24** of the certificate.

[**0044**] Upon receiving the data package, the correspondent **14** constructs the address of the certificate based on the information provided in the certificate locator **24**, uses that address to retrieve the certificate from the LDAP directory, **22**, extracts the public key of the correspondent **12** and verifies the CA's signature in the certificate using the embedded public key of the CA **20**. The message from the correspondent **12** is then verified using the extracted public key and the secure transaction completed.

[**0045**] The certificate locator **24** is generated in a manner that mitigates the bandwidth-latency, and number of exchanged messages required by the communication between the correspondents **12**, **14** and PKI **18** as follows. The RA **19** processes the information contained in the request for a certificate from the initiating client **12** to obtain the certificate locator of the certificate in the LDAP **22**. Similarly, the initiating client **12** processes the information in the request in the same manner to obtain the same certificate locator, which the client **12** sends later in the communication with the recipient **14**. The recipient **14** can then combine the certificate locator with previously known information about the location of the LDAP **22**, thereby allowing the recipient **14** to reconstruct the address of the certificate and retrieve it. Because the initiating client **12** can calculate the certificate locator, the need for a message from the RA **19** to the client **12** containing the certificate locator, has been eliminated.

[**0046**] The procedure for obtaining a certificate from the registration authority **19** for the correspondent **12** is shown on the diagram of **FIG. 2**. Initially, the correspondent **12** establishes a trusted relationship with the registration authority **19**. A secure connection is established between the client **12** and RA **19** in accordance with one of the established protocols, such as WLTS, SSL or TLS. After the secure connection is established, a certificate request **23** is prepared as indicated at **40**. The certificate request **23** includes a set of information that will vary from application to application. In one example indicated schematically at **FIG. 3** however the certificate request **23** includes a header **24** to indicate that the message is a certificate request, the correspondents public key **25**, identifying information **26** associated with the initiating correspondent **12**, such as a social insurance number or mothers maiden name, and a time varying indicator **27** such as a date and time stamp or counter.

[**0047**] The certificate request **23** is forwarded to the RA **19** who conducts checks in accordance with the implemented security policy and forwards at **50** the request to the CA **20**. The CA **20** will issue a certificate containing the public key of the initiating correspondent **12** and signed with the CA's private key. The CA **20** returns the certificate to the RA **19** for publication in the LDAP **22** as indicated at steps **60**, and **70**.

[**0048**] In order to publish the certificate, it is necessary to allocate an address at which the certificate may be found and that can be made known to other correspondents **14** in the PKI **18**. To provide the address of the certificate, a mathematical function, such as the secure hash function SHA-1 is applied to all or part, as is predetermined, of the information set in the certificate request **23**. All or a portion of the resultant output, e.g. the least significant bits, is used as the certificate locator **24**. In the example given therefore the certificate request includes the public key, pk_{12}; the identity ID_{12} and a time stamp T so the certificate locator **24** is the least significant bits of H (pk_{12}‖ID_{12}‖T). The address of the LDAP **22** within the network is known to each of the correspondents registered with the PKI **18** and accordingly the certificate locator is combined with known information identifying the address of the LDAP **22** to establish the address for the certificate.

[**0049**] The address of the certificate will be in the form of a uniform resource locator (URN) or uniform resource indicator (URI) in which the portion of the output of the hash function forms part to the path. For example, the URN of the certificate could be of the following format such as: ldap://www.cert-dir.com/wireless_dir/loc2553AC-2, where 'ldap' refers to the protocol, www.cert-dir.com the location of the directory **22** implementing the lightweight directory access protocol; and the balance the path to the certificate within the directory. The least significant bits of the output of the hash function are represented by the string 2553AC-2, which acts as the certificate locator **24**.

[**0050**] The initiating correspondent **12** similarly can compute the hash of the certificate request **23**, and select the least significant bits to obtain the string 2553AC2. The string is forwarded as part of the data package to the correspondent **14** during a transaction. The correspondent **14** uses the string as the certificate locator **24** to retrieve the certificate from the LDAP. The retrieval may be carried out in a number of different ways as described below.

[**0051**] In a first embodiment shown in **FIG. 4**, the location of the directory **22** is known to each subscriber of the PKI **18** and accordingly the recipient correspondent **14** combines the certificate locator **24**, i.e. the string, 255AC2 with the location ldap://www.cert-dir.com/wireless_dir/loc to derive the address of the certificate. The recipient **14** therefore directs a request for the certificate to that address and retrieves the certificate to verify the public key of the correspondent **12**.

[0052] In the above embodiment, it will be appreciated that it is not necessary for the RA **19** to send the URN of the certificate to the correspondent **12** and similarly it is not necessary for the entire address to be forwarded between correspondents. Accordingly, significant bandwidth is saved, one message communication (and its associated latency) is saved and the address of the certificate can easily be recreated by the recipient **14**.

[0053] In the event the recipient **14** is unable to recreate the address, the initiating correspondent **12** is able to reconstruct the address and send it in its entirety or alternatively, retrieve a copy of the certificate and forward it.

[0054] It will be appreciated that the bit string derived from the information in the certificate request **23** may be used as a pointer to the address of the certificate in the directory **22** with a mapping from the bit string to the actual location being performed at the directory **22** or at the RA **19**.

[0055] In another embodiment, the RA **19** may forward the certificate request to the CA **20** and the CA **20** will process the certificate request to obtain the certificate locator and will return the certificate and the certificate locator to the RA **19**, who will determine the address from the certificate locator and publish the certificate in the determined address in the LDAP directory. Alternatively, the RA **19** may forward the certificate request to the CA **20** and the CA **20** will process the certificate request to obtain the certificate locator, determine the address from the certificate and publish the certificate in the determined address in the LDAP directory. In each of the above two examples, the CA performs processing steps that are handled by the RA in the preferred embodiment. In general the division of labor between the RA and the CA may vary from system to system.

[0056] By including a time varying information in the certificate request, the output of the hash function will be different for each request made and accordingly the chance of collisions between the addresses computed will be minimized.

[0057] The mathematical function applied to the certificate request may be functions other than a hash function, such as a concatenation of the constituent information or an interleaving of the information, as the address is usually intended to be a matter of public record rather than a secret or secure.

[0058] As described above, the correspondent **14** reconstructs the certificate address in order to retrieve it. As an alternative, as shown in **FIG. 5**, the certificate locator **24** may be forwarded by the correspondent **14** to the RA **19** who constructs the address to the extent necessary to retrieve the certificate and return the address to the correspondent **14**. As another alternative, shown in **FIG. 6**, the certificate locator **24** may be forwarded to the RA **19** who constructs the address to the extent necessary to retrieve the certificate, retrieves the certificate, and returns the certificate to the correspondent **14**.

[0059] In a further embodiment illustrated in **FIG. 7**, it may be feasible to compute the certificate locator from information forwarded from the initiating correspondent **12** to the recipient **14** as part of the communication protocol. In such a case, the computation of the string and its inclusion in the message forwarded by the initiating correspondent **12** would not be necessary as the application of the function to compute the certificate locator **24** could be performed at the recipient **14**. However, in most cases it is believed that the string will be more efficient than including additional information in the protocol.

[0060] The above-described embodiments of the invention are intended to be examples of the present invention and alterations and modifications may be effected thereto, by those of skill in the art, without departing from the scope of the invention which is defined solely by the claims appended hereto.

1. A method of allocating an address to a certificate to be stored in an addressable database for subsequent retrieval, said method comprising the steps of generating a string for use as a certificate locator from information contained in a certificate request and utilizing said string to obtain said address.

2. A method according to claim 1 wherein said string is mapped to an address in said directory.

3. A method according to claim 1 wherein said string is used as said address in said directory.

4. A method according to claim 1 wherein a mathematical function is applied to said information to obtain said string.

5. A method according to claim 4 wherein said mathematical function is a hash function.

6. A method according to claim 5 wherein said string is a portion of the output of said hash function.

7. A method of identifying an address of a certificate to a recipient of a signed message in a data communication system, said method comprising the steps of preparing a set of information for inclusion in a certificate request, generating from said set of information a string for use as a certificate locator in a database, and forwarding said string to said recipient to indicate the location of said certificate in said database.

8. A method according to claim 7 wherein said information includes a time varying element.

9. A method according to claim 7 wherein a predetermined mathematical function is applied to said information to obtain said string.

10. A method for maintaining certificates in a public key infrastructure having a certification authority and a pair of correspondents, said method comprising the steps of collating at one of said correspondents information comprising a request for a certificate of said certification authority, forwarding said request to said certification authority, computing from said information comprising said request a string for use as a certificate locator by said one correspondent and said certification authority, storing a certificate issued from said request in a directory at an address obtained from said string and forwarding said locator from said one correspondent to another permit retrieval of said certificate from said directory.

11. A method according to claim 10 wherein said information includes a time varying element.

12. A method according to claim 10 wherein communication between said one correspondent and said certification authority is performed over a secure channel.

13. A method according to claim 10 wherein said other correspondent obtains an address of said certificate from a known address of said directory and said string.

14. A method according to claim 10 wherein said other correspondent forwards said locator to said certification authority for construction of said address.

15. A method according to claim 10 wherein said string is computed by application of a cryptographic hash function at least part of said request.

16. A method according to claim 15 wherein said part includes a time varying element.

17. A method according to claim 15 wherein a portion of the output of said hash function is used as said bit string.

18. A method according to claim 10 wherein said but string is utilised as a pointer to an address in a directory.

* * * * *