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Gagliano

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(54) **ENTERPRISE SECURITY SYSTEM**

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H04L 29/06	(2006.01)

(Continued)

(52) **U.S. Cl.**

CPC .... ***H04L 63/08*** (2013.01); ***G06F 21/31*** (2013.01); ***H04L 63/105*** (2013.01); (Continued)

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CPC ... H04L 63/08; H04L 63/1416; H04L 63/126; H04L 9/3218

USPC 726/2, 6, 27; 713/156, 163, 168, 175

See application file for complete search history.

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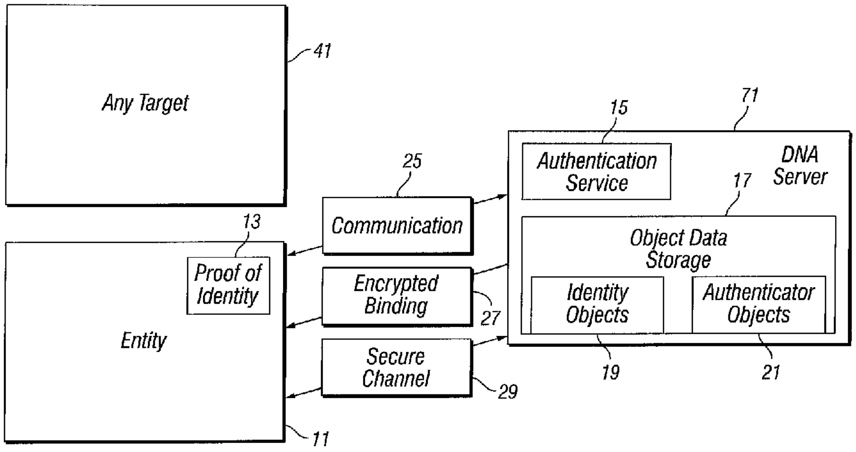
(57) **ABSTRACT**

A platform of Trust Management software which is a single, customizable, complete distributed computing security solution designed to be integrated into an enterprise computing environment. Digital Network Authentication (DNA) is the centerpiece of the system of the present invention. It is a unique means to authenticate the identity of a communicating party and authorize its activity. The whole mechanism can be thought of as a trusted third party providing assurances to both clients and servers that each communicating entity is a discrete, authenticated entity with clearly defined privileges and supporting data. Furthermore, the level of trust to be placed in the authorization of every entity communicating within the system is communicated to every entity within a distributed computing environment.

18 Claims, 4 Drawing Sheets



(51) **Int. Cl.**

G06F 21/31	(2013.01)
H04L 9/32	(2006.01)
G06F 15/16	(2006.01)
G06F 11/00	(2006.01)

(52) **U.S. Cl.**

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USPC **726/6**

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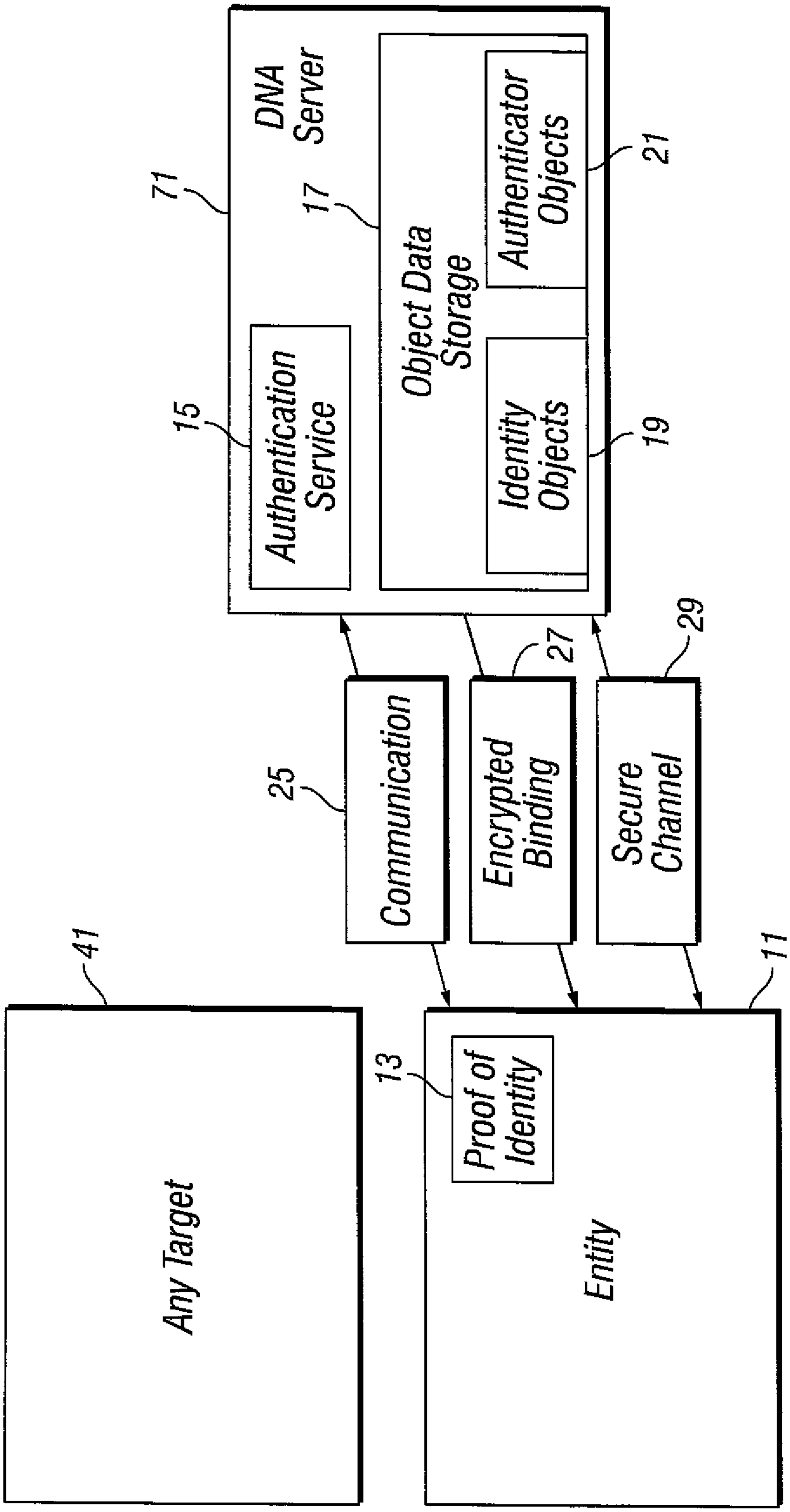
71
DNA Server
15
Authentication Service
17
Object Data Storage
Authenticator Objects
21
Identity Objects
19
25
Communication
Encrypted Binding
27
Secure Channel
29
41
Any Target
11
13
Proof of Identity
Entity

FIG. 1

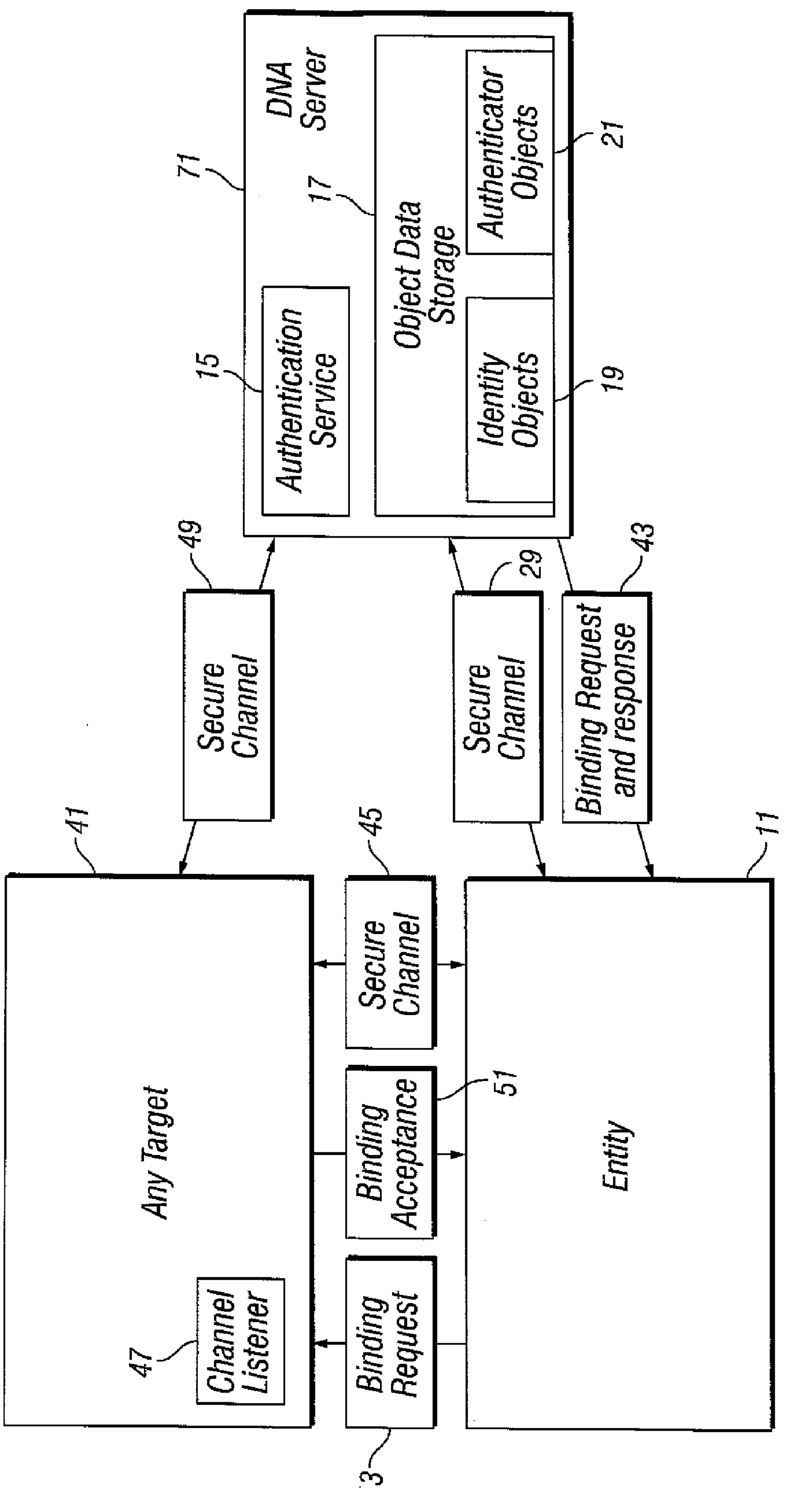
71
DNA Server
15
Authentication Service
17
Object Data Storage
19
Identity Objects
21
Authenticator Objects
49
Secure Channel
29
Secure Channel
43
Binding Request and response
41
Any Target
47
Channel Listener
45
Secure Channel
51
Binding Acceptance
3
Binding Request
11
Entity

FIG. 2

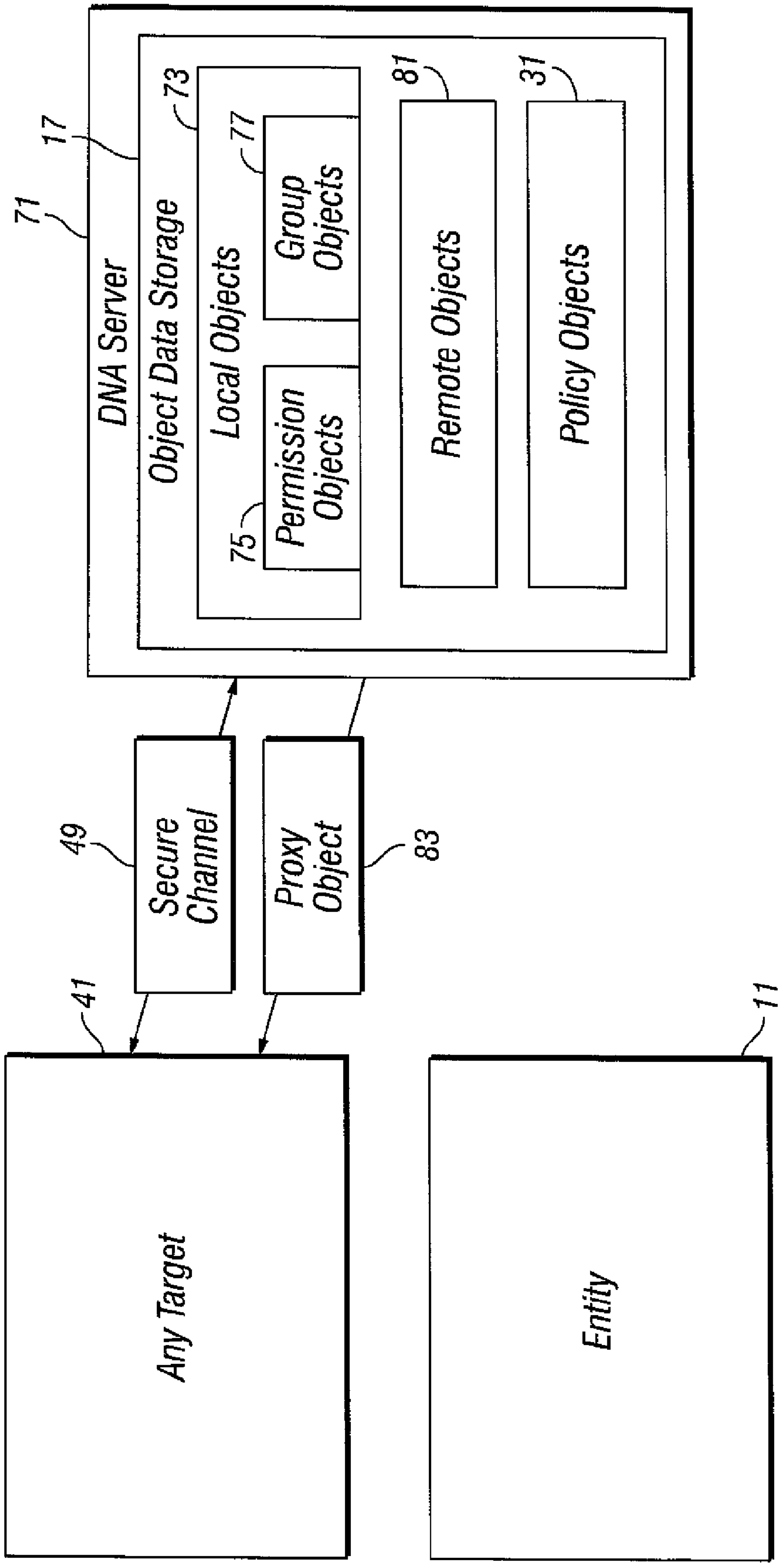
71
17
DNA Server
Object Data Storage
73
Local Objects
77
Group Objects
75
Permission Objects
81
Remote Objects
31
Policy Objects
49
Secure Channel
Proxy Object
83
41
Any Target
11
Entity

FIG. 3

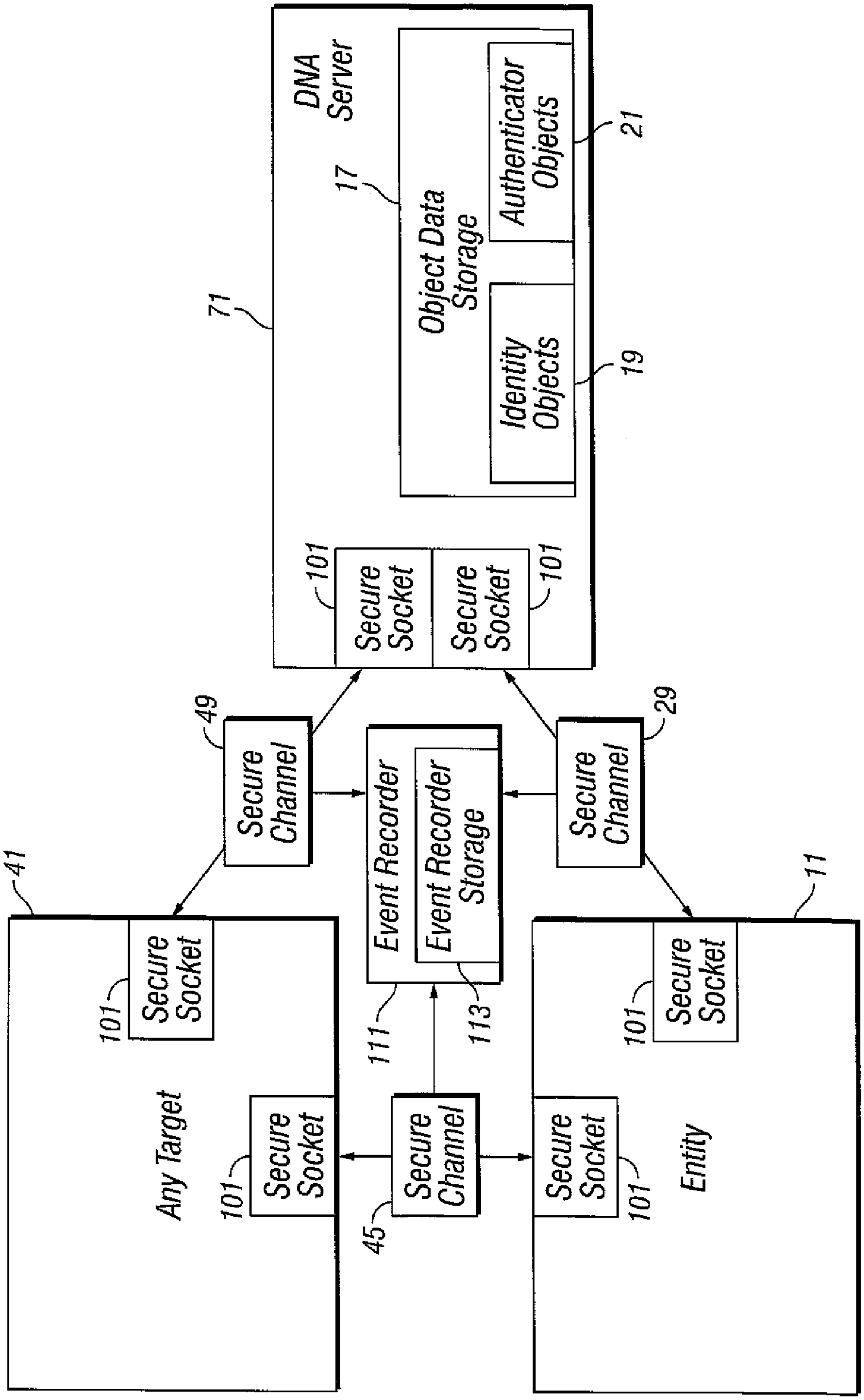
71
DNA Server
17
Object Data Storage
Identity Objects
19
Authenticator Objects
21
101
Secure Socket
Secure Socket
101
49
Secure Channel
Event Recorder
Event Recorder Storage
111
113
Secure Channel
29
41
Secure Socket
101
Any Target
Secure Socket
101
Secure Channel
45
Secure Socket
101
Entity
11
Secure Socket
101

FIG. 4

ENTERPRISE SECURITY SYSTEM

ENTERPRISE SECURITY SYSTEM

This application is a continuation application of U.S. patent application Ser. No. 12/872,479, entitled "Enterprise Security System", filed on Aug. 31, 2010, which is a continuation application of U.S. patent application Ser. No. 10/439,114, entitled "Enterprise Security System", filed on May 15, 2003 (U.S. Pat. No. 7,788,700), and the specifications and claims of both applications are incorporated herein by reference. This application also claims the benefit to and priority of U.S. Provisional Application Ser. No. 60/378,130, filed on May 15, 2002.

FIELD OF THE INVENTION

The present invention relates to an integrated computer software security platform for a distributed computing environment. More particularly, the present invention relates to a system to provide, within such a distributed computing environment, assurances that each communicating entity is a discrete, authenticated entity. For each authenticated entity, a trust level is assigned based on the method of authentication.

BACKGROUND OF THE INVENTION

Historically computer security was a matter of managing physical access to equipment. However, with the development of computer networks, new vulnerabilities have been introduced. Today's modem distributed computing environment (referred to herein as an "enterprise") is designed in such a way that at least a portion of the environment is vulnerable to many methods of tampering or eavesdropping or other security risks to the information contained within that environment. These risks are both internal to the enterprise and external. Existing solutions for addressing these vulnerabilities is to first try to identify where the vulnerabilities exist and then to add some sort of protection mechanism to each identified vulnerability. This typically results in a patchwork of independent protection mechanisms which are not only time consuming and expensive to construct, hut also do not protect against vulnerabilities which may exist but have not been recognized. For a large enterprise, the security solutions are, typically, not enterprise wide.

Due to the very open nature of the common communications protocols used to knit a collection of devices (e.g., terminals, servers, applications, databases, etc.) together, the problem of ensuring all aspects of security is complex. In addition, as the use of computer systems becomes more pervasive, the challenge and importance of clearly authenticating the identity of every entity interacting with the enterprise increases as the concern over the risks associated with inappropriate access to information grows.

These risks are beginning to be recognized by current and planned legislation such as the "Health Insurance Portability and Accountability Act of 1996 ((HIPAA)." Additionally, in the financial services area there are several interagency "Guidance" documents on "Authentication" and "Safeguarding Customer Information." See: http://www.bmck.com/ecommerce/fedlegis-s-fi.htm for a list of such documents. Information quality can only be attained by capturing information from trusted, high quality sources.

Meaningful access controls can only be implemented when the identity of those entities requesting access can be reliably authenticated. Patchwork solutions to computer and network security problems are expensive and notoriously unreliable. Expensive, specialized skill human resources are required to install and maintain each element of the patchwork. One attempt at addressing these problems is the Kerberos system which is a network authentication protocol developed at MIT and documented in publications of the Internet Engineering Task Force (IETF). It is designed to provide strong authentication for client/server applications by using secret-key cryptography. The Kerberos protocol attempts to address the entity authentication problem but does not incorporate the "trust level" concept of the present invention. Further, it has no mechanism for access or authorization controls, or auditing.

Further, none of the prior art incorporates the elements of computer security within an enterprise where user can use a single sign-on for authentication and authorization which can be carried from, for instance, server to server to application, ensuring that the user, server or application is authorized and trusted to perform whatever action is requested.

Moreover, no current approach addresses the concept of different levels of trust for each entity, depending on the access requested to a particular server, application or database, etc., and also on the type of authentication used to request that access. Treating all authentications as equal results in a single trust level that is universally granted to all properly authenticated entities regardless of what type of authentication information is presented or the method in which it is communicated. This universal trust level does not address the environments of real world distributed computing environments where some activities are low risk and thus a low quality authentication of the relevant entities is sufficient, white other activities entail very high risks and should be allowed only when strong, highly reliable, and attack resistant authentication of relevant entities are used. For instance, low risk activities might involve an entity accessing some sensitive information which is available to any entity wilting to identify itself and give a reason for needing access. Higher risk activities might involve an entity accessing systems which handle financial transactions on behalf of that entity. Even higher risk activities might include initiating financial transactions on behalf of entities where the interests of multiple entities (e.g., institutions) are involved. Still higher level risks would be associated with administrative access to the systems providing services mentioned above. In some highly sensitive cases it would be appropriate to require collaboration among several entities (e.g., officials in an institution) in order to complete an activity.

Finally, the current security systems within distributed computing environments only have the capability to communicate to the server the identity of an entity requesting access to the enterprise. Once this authentication has taken place, that entity is then free to access any other target entity (e.g., another server, application or database) communicating within the environment without notifying those other target entities of the identity of the entity pursuing such communication, much less requiring further authentication from these other entities.

Therefore, what is needed is a communications protection system which extends to all elements within a distributed computing environment which provides assurances that each entity within the environment attempting to communicate with or access other entities within that environment is a discrete, authenticated entity with an associated trust level.

OBJECTS OF THE INVENTION

It is an object of the invention to provide a system to authenticate the identity of every entity attempting to communicate with and within a distributed computer environment.

It is another object of the invention to assign one or more trust levels to all entities attempting to communicate with various targets (e.g., services, applications, data bases, etc.) in a distributed computing environment and securely communicate the associated trust level with all communications between the entity and those targets.

It is another object of the invention to provide secure channels for facilitating and protecting communications between entities in a distributed computing network.

It is another object of the invention to provide a secure storage facility for data objects and for entities to have tightly controlled access to those data objects applicable to the service it provides to a particular entity.

It is another object of the invention to provide a secure storage facility which is specifically designed to be usable as a store of access control data and also designed to ensure utility and applicability for numerous other purposes, including applications not currently required by the distributed computing enviroment.

It is another object of the invention to securely audit and record all instances of authentication activity within the distributed computing environment, and any anomalies which may indicate possible security penetration attacks.

It is another object of the invention to provide an extensible mechanism for analyzing activity for security, performance and other analysis to allow adaptation of the invention to future needs without modification of the original invention.

It is another object of the invention to provide a system to authenticate the identity of every entity attempting to communicate within a distributed computer environment that is transparent to the entity and target entities of that system.

It is another object of the invention to provide the foregoing objects with the minimum amount of education and system development expenses.

SUMMARY OF THE INVENTION

The present invention is a security platform to allow distributed computing environments to be enhanced (or designed and built) to provide: authentication of all users accessing the environment; secure inter-system communications; a flexible high quality authorization and supporting services store; an extensive auditing mechanism; and immediate recognition and reporting of attempts at inappropriate use. The integration of all these facilities in a seamless manner, with every component taking advantage of strong cryptographic techniques, results in a unified environment of trust and control. Common functions needed by nearly every distributed computing environment providing services either to other service processes or end users, which have in the past been only available through independent patchwork solutions, are consolidated into a security platform which will universally control access and assign one or more trust levels to every entity attempting access either to the enterprise itself or a particular network, server, application etc. within the enterprise. This authentication and assignment of trust levels to every such entity is referred to herein as the Digital Network Authentication (hereafter referred to as "DNA"). DNA dramatically lowers the cost associated with developing secure distributed systems by making a few straightforward additions to the fundamental concept of a communications socket which enables systems, servers, applications etc., to communicate with one another. The invention adds message transport protection, communicating entity identification, and a measure of the amount of trust to be placed in that identification. Target entities gain access to the additional capabilities of the DNA secure storage, which includes the capability of grouping certain entities with one another or applying an authentication or authorization policy to one or a group of entities. Developers need only use an ESS socket object in place of their conventional socket object when writing their software in order to gain all the advantages of the present invention. Essentially, the system of the present invention inserts itself between current "socket" implementations and the application programs that use them to provide enhanced security and some additional functionality with very little impact on the application software developer and can thusly be used as the transport for higher level concepts such as access to software objects and calling procedures which already exist within an enterprise.

BRIEF DESCRIPTION OF THE DRAWINGS

A complete understanding of the present invention may be obtained by reference to the accompanying drawings, when considered in conjunction with the subsequent, detailed description, in which:

FIG. **1** is a block diagram depicting the authentication of an entity.

FIG. **2** is a block diagram depicting the communications to the targets between one entity and such target within a distributed computer system.

FIG. **3** is a block diagram depicting the communication of the characteristics of an entity attempting to access a target within a distributed computer system.

FIG. **4** is a block diagram depicting various protection and security mechanisms for a distributed computer system.

For purposes of clarity and brevity, like elements and components will bear the same designations and numbering throughout the figures.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** illustrates the three basic components of the enterprise security system: entity **11**, DNA server **71** and target **41**. Entity **11** represents any user accessing a computer terminal, or a hardware application, or a software application or a server which needs to access target **41**, which is also any user accessing a computer terminal, hardware application, software application or server. The software application can be, for instance, data bases such as accounts payable, accounts receivable, general ledger, payroll, inventory control, maintenance management, sales history, etc. Access is initiated by entity **11** establishing a communication **25** with DNA server **71** in an attempt to be authenticated. Within communication **25**, entity **11** will communicate its proof of identity **13**. This proof of identity **13** will then prompt the authentication service **15** within DNA server **71**, to authenticate this proof of identity. This is accomplished by DNA server **71** retrieving from object store **17** the identity objects **19** and authenticator objects **21** associated with entity **11** according to the proof of identity **13** as communicated by entity **11**. The proof of identity can range from a user name and password (low proof), to a user name, password and thumbprint (higher proof) to, for instance, a key (still higher proof).

The process of authentication can be accomplished through a variety of methods. Authenticator objects **21** can be, for example, a unique user name along with an associated password (secret) or some transformed version of the password. Because entity **11** would communicate this password or secret in the form of proof of identity **13** when requesting authentication, authenticator service **15** will authenticate entity **11** if the correct password as stored in authenticator object **21** is given. In one embodiment, authentication service **15** issues a challenge to entity **11**, delivered in the form of a random number that is encrypted using a key derived from the password (secret) shared between entity **11** and authenticator object **21**. Based on the information contained within proof of identity **13**, entity **11** responds to this challenge by transforming the random number in the challenge message by computing a hash value using, for example, the SHA-1 or MD5 algorithm, and returning this hash value to authentication service **15**, which wilt then verify that the computed hash value returned by entity **11** was computed correctly. In this way, proof of knowledge of the user name and password is verified without having to transmit that data over communication **25** between entity **11** and DNA server **71**. This embodiment would also incorporate such features as timestamp and nonce values to prevent replay and pre-computed dictionary attacks which would allow someone to mount a high-speed offline attack against the authenticator service **15** and guess the password being used by entity **11**. Based on the type of authentication engaged in by entity **11**, DNA server **71** will assign a level of trust to entity **11**. This level of trust is the amount of confidence that authentication service **15** has that entity **11** is indeed entity **11**. The greater the proof of identity **13**, the higher the trust level assigned by DNA server **71**.

Once entity **11** is authenticated by authentication service **15** of DNA server **71**, it receives a binding **27** with DNA server **71**. This binding **27** is a packet of encrypted information which provides the necessary cryptographic keys and tokens necessary establish a secure channel **29** between entity and DNA server **71**. For example, binding **27** will contain a randomly generated secret to be used by entity **11** when encrypting and signing future messages to the DNA server **71**, the trust level value assigned by DNA server **71**, and the expiration time of the binding **27** between entity **11** and DNA server **71**.

As alluded to above, there are various methods for an entity **11** to authenticate itself with DNA server **71**, and thus varying levels of trust that will be assigned to that entity **11**. Another type of authentication, such as that based on an X.509 public key certificate, might contain only the distinguishing name (DN) expected in the certificate supplied by entity **11** in its proof of identity **13** when requesting authentication to DNA server **71**. The certificate itself would supply the public key need for encrypting a binding **27** between entity **11** and DNA server **71** that is returned by authentication services **15**. Validating the proof of identity **13**, which in this case is in the form of the submitted certificate, would involve checking expiration dates and following the chain of certification signatures until a trusted root certificate was reached. The set of trusted root certificates can be stored as another identity object **19** in object sic **17**. Again, time stamp and nonce values can be used to secure these communications.

Depending on the type of authentication, the authentication service **15**, using authenticator object **21**, possibly in conjunction with some policy object **31** (discussed below), would establish the numerical trust level which is, again, a system-wide measure of confidence that entity is, indeed, the rightful owner of the proof of identity **13**. This trust level would be securely recorded in binding **27** returned to entity **11** by DNA server **71**. Trust level is indicative of the method of authentication utilized by entity **11** in its initial communication with DNA server **71**.

Additional enhancements involve the storage of secrets and the performing of cryptographic transforms in special hardware token devices such as smart cards. These devices can provide a much higher degree of control over the secret information they contain than the typical general-purpose computer that contains essentially no high security storage mechanism. Further enhancements involve the use of a biometric measurement of a human characteristic such as a fingerprint. This biometric reading can be encrypted and sent to the authentication service **15** along with the authentication request and proof of identity **13** within communication **25** as additional supporting proof that entity **11** is truly the entity identified in proof of identity **13**. As indicated above, this biometric measurement type of authentication would result in a higher level of trust placed in entity **11** by DNA server **71** through authenticating service **15**.

Once authenticated, as shown in FIG. **2**, entity **11** can request a second binding **43** from DNA server **71** to access target **41**. In response, DNA server **71** will return binding **43**, which will contain the necessary cryptographic keys and tokens necessary for establishing a secure channel **45** between the entity **11** and the target **41**. For example, binding **43** may be a packet of information which contains a secret (typically encrypted) that target **41** will use to sign and encrypt messages it sends to entity **11**, a bundle of data to be presented to target **41** as proof of the identity of entity **11**, and the expiration time of the binding **43**. Target **41** incorporates a conventional channel listener **47** to field these incoming communications requests. If target **41** accepts binding **43**, it wilt send an acceptance **51** to entity **11**, and establish secure channel **45**. Not only is a secure channel **45** established between the entity **11** and target **41** by using binding **43**, but the identity **13** of entity **11**, with the associated trust level given to entity **11** by DNA server **71** is securely delivered to target **41**. Thus, DNA server **71**, entity **11**, and target **41** all have information regarding the level of trust to be placed in entity **11**, and, unless a different type of authentication is used by entity **11**, this level of trust is not changeable. Additionally, binding **43** will enable entity **11** to verify that target **41** is indeed the entity with which it desires communication.

Once target **41** has established a secure channel **45** with entity **11**, target **41** will normally use a third secure channel **49** to the DNA server **71** (established after the target **41** successfully authenticated itself to the DNA server in a process analogous to that used by entity **11** to request the various DNA objects relevant to target **41** and associated with entity **11** which are stored in object store **15**.

FIG. **3** shows the request for, and exchange of, various pieces of information, referred to as DNA objects, which are stored in the object store **17** of DNA server **71**. This request from target **41** will communicate to DNA server **71** the identity of entity **11** and the level of trust initially assigned by DNA server **71** to be placed in entity **11**. DNA server **71** will then retrieve from object store **17** only those objects associated with entity **11**. These objects fall into two broad categories, local objects **73** and remote objects **81**, with a third a third type of object referred to as policy objects **31**.

First there are local objects **73**, copies of which are sent to target **41**. Local objects **73** are copied at the time target **41** requests the DNA objects for entity **11** from DNA server **71** and may consist of, for example, simple name/value permission objects **75**, which are tested by target **41** before allowing entity **11** to access some resource managed by target **41**. As an example, if target **41** is a service that provides access to a data table of records, permission objects **75** might be: QUERY, ADD, MODIFY, and/or DELETE. If entity **11** has the permission to perform any or all of these functions, the corresponding permission objects **75** must first be present within the local objects **73** of object store **17** and then must be copied to target **41**. If the appropriate permission objects **75** are not present in object store **17**, these permission objects **75** obviously cannot be copied to target **41** and thus entity **11** will not be allowed to perform those functions within target **41**.

It is within this mechanism that the level of trust placed in entity **11** by DNA server **71** becomes critically important. Permission objects **75** (as well as any DNA object) may be conditioned upon entity **11** achieving a certain level of trust. As stated previously, target **41** communicates both the identity of entity **11** and level of trust associated with that entity **11** to DNA server **71** when requesting the DNA objects. One of the inherent features of permission objects **75**, is the level of trust required in order for these permission objects **75** to copied to target **41**. Therefore, it is possible for an entity **11** to have an associated permission object **75** in object store **17** for accessing target **41**, but nonetheless be denied the access these permission objects **75** provide due to an insufficient level of trust attained by the method of authentication used by entity **11**. The result in such a situation is that DNA server **17** will refuse to copy a permission object(s) **75** to target **41**, and without such permission object(s) **75**, target **41** will not allow access to entity **11**. However, if entity **11** used a more secure or trustworthy method of authentication, this level would be communicated from target **41** to DNA server **71**. If the requisite trust level of permission object **75** is now satisfied, permission object **75** would be copied to target **41**, thus allowing entity **11** to access target **41**.

These permission objects **75** serve various functions. For instance, another valuable use of name/value permission objects **75** is the storage of auxiliary authentication credentials. Additionally, if target **41** is a service that provides a gateway to a legacy system or application which cannot be updated to directly participate in the system of the present invention, target **41** can present authentication credentials to that legacy system on behalf of entity **11**. In that case, target **41** could query entity **11** for the necessary credentials (or they could be supplied by a security administrator) which are stored as a permission object **75** in object store **17**. Once copied to target **41**, target **41** could transparently present the appropriate credentials to the legacy system. Another valuable use of name/value permission objects **75** would be personal customization information. Target **41** could offer entity **11** the capability to customize how target **41** responds to the requests of entity **11** or even heuristically analyze the behaviors of entity **11** to tailor itself to better meet the typical usage of entity **11**. The DNA server **71** provides a safe, secure, easy-to-access and reliable storage facility for this client-specific information in object store **17**.

Another type of local object **73** is group objects **77**. If the data records of an enterprise are organized into groups, the identification information, characteristics and requisite trust levels associated with each group and the corresponding authorizations associated with the members of the group, are stored in object store **17** as group objects **77**. This is useful in designating administrators of information that falls within certain groups. It is very common practice for more than one entity **11** to be grouped together, or assigned roles as in RBAC terminology, because they possess one or more characteristics in common. DNA server **71** is programmed to understand this and transparently hides the details of this from target **41** when retrieving DNA objects for the object store **17**. For instance, when target **41** requests the DNA objects of entity **11**, DNA server **71** implicitly and transparently constructs the collection of DNA objects from object store **17** that are uniquely associated with entity **11** including group objects **77** (if any). Thus, entity **11** transparently inherits all the group objects **77** of the groups to which it belongs. In addition, if target **41** is associated with a group, it can request from DNA server **71** those characteristics of entity **11** (or any group objects **77** associated with entity **11**) that may have an impact of the group objects **77** of target **41**.

The second type of objects located in object store **17** are remote objects **81**, which exist only in the DNA server **71**, that is no copy of these objects are sent to target **41**. Remote objects **81** are invoked by target **41** through a emote method invocation (RMI) type mechanism which is transported over secure channel **49**. Instead of being copied to target **41**, target **41** receives a handle or proxy object **83**, which intercepts the RMI requests and forwards them for processing through secure channel **49** to the instance of the proxy object **83** in DNA server **71**. In the realm of access authorization, these remote objects **81** can implement a number of sophisticated policies. Since the remote object **81** is only contained in DNA server **71**, it can be programmed to maintain knowledge of multiple concurrent activities and needs of entity **11**. Other uses of remote objects **81** include mini-services that, because of their location in DNA server **71**, could provide high performance maintenance functions on other DNA objects. Again, any of these objects could be conditioned on a requisite level of trust being attained by entity **11**.

The third type of objects stored in object store **17** are policy objects **31**. DNA server **71** is capable of providing a fully compliant implementation of NIST-RBAC-STD through the incorporation of policy objects **31**. This standard, developed by the US National Institute of Standards and Technology, specifies a Role Based Authorization Control (RBAC) methodology in which an entity **11** is assigned to a group having a corresponding group object **77**, with the group object **77** having at least one specified permission object **75** associated with it. In addition, constraints such as exclusionary roles and minimum sufficiency can be specified. For instance, if an exclusionary policy is included in policy object **31**, which is associated with entity **11**, and policy object **31** limits the amount of permission objects **75** to three concurrent permission objects, DNA server **71** will not allow entity **11** to access more than three of these permission objects **75**. Additionally, a complimentary policy to (although not directly associated with) RBAC methodology would be a collaborative policy contained within policy object **31**, in which case DNA server **71** would require a quorum of entities **11** to be authenticated within DNA server **71** before a permission object **75** would be granted to any of them. Another kind of policy object **31** would be to provide a global one-user-at-a-time policy over a set of services.

All DNA objects, whether local or remote, contain two data elements understood and managed by the DNA server **71**. First, each object within object store **17** contains an expiration date. This provides a self-cleaning mechanism that helps prevent objects from persisting beyond their useful life. Second, each object within object store **17** contains a reference to the identity object **19** of the administrator of that object. A notification to an object's administrator is sent when that object expires. Expiration events also provide the prompting to re-evaluate security decisions made previously, possibly by another person who is no longer involved. Expirations can be defined as hard, in which case the object becomes invalid and an immediate candidate for removal from object store **17**. They can also be defined as soft, in which case they persist and are valid during a grace period that is established by a configurable policy object **31**.

The second data element contained in each object located in object store **17** is the trust level. As discussed above with reference to the description of permission objects **75**, each time entity **11** authenticates to DNA server **71**, it is assigned a trust level based on the authentication method used and the credentials provided as proof of identity **13**. This trust level is securely forwarded to target **41**, and target **41** communicates this level of trust back to DNA server **71** when requesting the DNA objects associated with entity **11**. DNA server wilt then only return those objects for which the requisite trust level has been attained by entity **11**. Since the trust level assigned by the authentication service **15** is a reflection of its confidence that entity **11** is in fact entity **11**, it is very appropriate to base authorization and other decisions on the sense of risk associated with allowing access to information resources and systems. For example, a simple username/password authentication might be sufficient to gain access to non-critical data and service functions. The trust level associated with this authentication would not be very high but, for low-risk functions, would be considered sufficient. If entity **11** authenticates using two or three factor security such as an encrypting token device augmented by a PIN or password and possibly a biometric element such as a fingerprint, a significantly higher level of trust would likely be assigned by DNA server **71**. This higher level of trust could be used to grant access to sensitive system administration functions such as granting access permissions to other entities. Because this level of trust is generated upon the initial communication between entity **11** and DNA server **71** and not only accompanies any attempt by entity **11** to access a target **41**, but also any communication between a target **41** and DNA server **71**, an entity **11** can never modify or create objects such that they would specify trust levels higher or lower than the level currently assigned to entity **11**. This ensures that an administrator cannot enhance their own access or that of others beyond their own authority. Furthermore, it is quite reasonable for administrators to employ multiple methods of authentication depending on the targets they wish to access.

The process described above and shown in FIGS. **1**-**3** culminates in a single sign-on system. The permissible actions allowed to be taken by entity **11** are pre-determined and programmed into DNA server **71**. Thus, with a single sign-on, entity **11** will essentially allow DNA server **71** to analyze whether or not entity **11** should be allowed access to a target **41**, conditioned by the level of trust placed in the type of authentication engaged in by entity **11**. Furthermore, because the identity and level of trust associated with entity **11** is propagated to every target **41** accessed by entity **11**, every target **41** can continue to propagate the identity and level of trust associated with entity **11** whenever the need arises without further prompting from entity **11**.

FIG. **4** illustrates the use of secure socket **101**. Such a socket provides a superset of the functionality of a conventional communications socket layered on top of the secure channels of the enterprise, such as secure channels **29**, **45** and **49**. This makes it very simple for a software application writer to employ the system of the present invention when developing applications which communicate with other applications within the enterprise. The programming semantics of sending and receiving data are identical to conventional, non-secure sockets with the exception of initial connection setup. Additional functionality optionally available to the developer if they wish to take advantage of it when using a secure socket **101** is in the area of access to the proof of identity **15** (as shown in FIG. **1**) of the entity **11** at the other end of the secure socket connection and access to DNA objects associated with entity **11** and target **41**. Another important aspect of the present invention is the event recorder **111** which consolidates messages coming from all secure channels (e.g. secure channels **29**, **45** and **49**), as well as routine operations events and anomalies detected by DNA server **71** and writes them to the event recording store **113**. In addition, the event recorder **111** provides a subscription capability to other authorized services so that the event messages can be analyzed, for instance by a health monitor, for security attack patterns, and can generate system performance characteristics. Conditions of concern detected by such a health monitor include:

Repeated authentication failure attempts from the same source indicating a possible attempt to guess authentication credentials.

Repeated message corruption indicating a possible attack against a secure channel or a network pathway damaging packets during transmission.

Attempts to use expired or revoked credentials that might indicate an attempt to gain unauthorized access to secured entities,

Messages containing expired timestamps and/or duplicate nonce values at might indicate a message replay attack.

Taken together the features and functions of the DNA service provide a powerful, generalized, secure, and extensible platform for sophisticated authorization and customization capabilities.

For the purposes of illustration only, without intending to limit any of the possible embodiments of the present invention, a practical application of the present invention is described below in connection with a hypothetical corporation. Within this corporation are three departments, Accounting, Operations, and Sales and Marketing. Within these three departments are various systems. Within Accounting, there is an accounts payable system, an accounts receivable system, a general ledger, and a payroll system. Within Operations there is a plant systems system, an inventory control system, and a maintenance management system. Finally, within Sales and Marketing, there is a contact management system, a sates history system, and a presentation tools system. It is foreseeable that an employee, such as an accounts payable clerk, would need full access to some of these systems, limited access to others, and may not need to access some systems at all. Within this criteria, the system of the present invention would perform as follows.

The clerk would normally sign in at his computer terminal. By this action, the DNA server would authenticate the username and password and establish a binding between the clerk and DNA server if the clerk's identity is property authenticated. The clerk would then open a web browser which would automatically initiate a request for the corporate facilities menu. The clerk sees the corporate facilities main menu presented. The menu system employed at this company chooses to only present the systems that the user has some access to. This user does not have access to the Sales and Marketing systems, so that option does not appear on the users menu. Although the user has access to some, but not all of the functions within Operations, the Operations menu is none the less displayed. The mechanics of this is accomplished within the system by a request being sent to the DNA server asking for a binding to the corporate facilities menu server. With this binding, the user's session can build a secure socket to the corporate facilities menu server and request the main menu. Because a secure socket is used, the corporate facilities menu server has the authenticated identity of the clerk. Using it's binding to DNA server, the server requests the DNA associated with our AP clerk.

Next the clerk would select the accounts payable system within the menu displayed. By virtue of this user being an accounts payable clerk and for the purposes of this illustration, the clerk is capable of entering or viewing any vendor information, but not able to prepare or print checks. The authorization needed is granted and the Accounts Payable menu is displayed. The mechanics within the system for accomplishing this are that, because the accounts payable system is separate from the corporate menu system, the user's session uses its Binding to DNA server to request a binding to the accounts payable system. The user's session then uses this binding to build a secure socket to the AP system and request the name menu. The accounts payable system, using its secure socket to DNA server requests the DNA associated with the user.

Within the accounts payable system, the clerk wishes to enter bills and thus selects "Enter Bills" within the system. The authorization needed is granted and the accounts payable bill entry form is displayed by the DNA Server, using its secure socket to the accounts payable system. Within this system, the clerk could select options such as "Print Cash Requirements," "Inventory Control," or "On Hand Report" and because the users DNA is already known by the system, the system has determined that the clerk has permission to access these files and allows the clerk to do so. However, if the clerk desired to access the payroll system, he would not be able to due to the fact that because access to this system was not given with his DNA. The DNA server did not find a permission object to access this system, thus no permission object pertaining this system was copied to the accounts payable system, and the accounts payable system would not display this option of the cleric's screen. All of these instances of authentication and access would be recorded to the event recorder. A health monitor would then receive this data from the event recorder and analyze this data. Abnormal conditions detected by the health monitor can be automatically reported to enterprise operations personnel for additional analysis and possible corrective response.

Since other modifications and changes varied to fit particular operating requirements and environments will be apparent to those skilled in the art, the invention is not considered limited to the example chosen for purposes of disclosure, and covers all changes and modifications which do not constitute departures from the true spirit and scope of this invention.

What is claimed is:

1. A non-transient computer-readable medium comprising computer software comprising code for providing one time authentication to a distributed computing environment using any known authentication mechanism and assigning a level of trust to the authentication mechanism used, wherein-authentication is separated from authorization, allowing authorization to be based on said level of trust to secure communications within said environment, and wherein said environment includes at least one originating entity and at least one target entity and one or more trusted third party servers, said one or more third party servers evaluating said authentication mechanism used by said originating entity and assigning a level of trust calculated by the confidence it has in the authentication mechanism used, wherein said level of trust can be used to dynamically change access within said environment, said entity selected from the group consisting of uniquely identifiable computer services on a computer, uniquely identifiable computers on a computer network, uniquely identifiable BIOS residing in a computer, uniquely identifiable computer chips residing in a computer, uniquely identifiable devices attached to a computer, uniquely identifiable devices capable of independent communication on a computer network, uniquely identifiable operating systems running on a computer, uniquely identifiable applications running on a computer, uniquely identifiable instances of an application running on a computer, uniquely identifiable business processes running on a computer, uniquely identifiable instances of a business process running on a computer, and uniquely identifiable persons, said code comprising:

a. code for authenticating the identity of said originating entity using one of a predetermined plurality of known authentication mechanisms, said mechanism being separately evaluated and assigned a level of trust by said server, said authentication of identity being limited in use to authentication only, and wherein not all of the predetermined plurality of authentication mechanisms are trusted at a same level of trust other than untrusted;

a1. code for evaluating via said server how secure is said authentication mechanism used by said now authenticated originating entity;

a2. code for calculating the confidence said server has in the instance of the authentication mechanism used;

a3. code for assigning a level of trust that will be associated with said confidence;

a4. code for dynamically calculating using said level of trust what authorization, access and information can be granted to said originating entity regarding said target entity;

b. code for transmitting a response, from said server to said originating entity regardless of the authentication mechanism used, containing a first binding element composed of at least a random number encrypted using a key derived from a secret stored by the said server about the originating entity and its request to access said target entity, and a trust level indicating the level of confidence said server has associated with said originating entity's authentication mechanism instance;

c. code for transmitting a second request that changes and transforms said response containing a first binding element by using knowledge of the same secret of itself, from said originating entity regardless of the authentication mechanism it has used, to said server, thereby requesting a second binding element from said server;

d. code for transmitting a second response containing said second binding element including a randomly generated unique signature regarding said originating entity and its request to access said target entity to be used by said target entity, from said server to said originating entity;

e. code for transmitting said second response containing said second binding element, from said originating entity to said target entity;

f. code for transmitting a response from said target entity to said originating entity indicating access acceptance of said originating entity by said target entity; and

g. code for creating a secure communication link between said target entity and said originating entity based on said evaluations, assignments and calculations.

2. The medium as set forth in claim **1**, further including code for creating a secure communication link between said server and said originating entity based on said evaluations, assignments and calculations.

3. The medium as set forth in claim **2**, further including code for creating a secure communication link between said target entity and said server based on said evaluations, assignments and calculations.

4. The medium set forth in claim **3** further including:

a. code for providing an event recorder, where said event recorder is authenticated and authorized based on said evaluations, assignments and calculations;

b. code for transmitting chosen events from within said secure communication link between said originating entity and said target entity, said entities authenticated and authorized to access said event recorder based on said evaluations, assignments and calculations to said event recorder;

c. code for transmitting chosen events from said originating entity to said event recorder; and

d. code for transmitting chosen events from said target entity to said event recorder.

5. The medium as set forth in claim **4**, further including at least one of:

a. code for transmitting chosen events from within said secure communication link between said originating entity, authenticated and authorized based on said evaluations, assignments and calculations, and said server to said event recorder; and

b. code for transmitting chosen events from said secure communication link between said target entity, authenticated and authorized based on said evaluations, assignments and calculations and said server to said event recorder.

6. The medium as set forth in claim **5**, further including:

a. code for monitoring said chosen events for pre-selected types of activities; and

b. code for reporting said events to any said entity authenticated and authorized to receive said events, based on said evaluations, assignments and calculations.

7. The medium set forth in claim **1**, further including code for maintaining objects wished to be held in secure storage associated with said originating entity, said objects selected from the group consisting of authentication, authorization, permission, name/value, credential, client specific, group, group information, group membership, personalization, legacy system access, role based authorization control, and other objects wished to be private, and including:

a. code for storing in said server one or more objects associated with said originating entity, each requiring a sufficient level of trust for assignment;

b. code for sending a request from said target entity to said server for one or more objects regarding said originating entity, which has been authenticated and whose authentication mechanism instance has been assigned a level of trust, from said server;

c. code for selecting from said secure storage, utilizing said level of trust that said server has established for said originating entity's authentication mechanism instance, one or more of said objects associated with said originating entity and only retrieving said objects that do not exceed said level of trust;

d. code for transmitting said selected objects from server to said target entity; and

e. code for utilizing said selected objects to establish the level of authorization granted to said originating entity regarding said target entity.

8. The medium set forth in claim **5**, further including:

a. code for providing a method to monitor the operational characteristics of all links said server has participated in establishing;

b. code for monitoring all communications between said server, said originating entity and said target entity;

c. code for recognizing abnormal characteristics and communications within said communications; and

d. code for reporting of said abnormal characteristics and communications to the event recorder, using said established secure communication link to said event recorder without participating entities being aware that reporting is taking place.

9. The medium set forth in claim **1**, further including code for assigning a time stamp and a nonce value to all communications between said server, said originating entity and said target entity.

10. A non-transient computer-readable medium comprising computer software comprising code for providing one time authentication to a distributed computing environment using any known authentication mechanism and assigning a level of trust to the authentication mechanism used, wherein-authentication is separated from authorization, allowing authorization to be based on said level of trust to secure communications within said environment, and wherein said environment includes at least one originating entity and at least one target entity and one or more trusted third party servers, said one or more third party servers evaluating said authentication mechanism used by said originating entity and assigning a level of trust calculated by the confidence it has in the authentication mechanism used, wherein said level of trust can be used to dynamically change access within said environment, said code comprising:

a. code for authenticating the identity of said originating entity using one of a predetermined plurality of known authentication mechanisms, said mechanism being separately evaluated and assigned a level of trust by said server, said authentication of identity being limited in use to authentication only, and wherein not all of the predetermined plurality of authentication mechanisms are trusted at a same level of trust other than untrusted;

a1. code for evaluating via said server how secure is said authentication mechanism used by said now authenticated originating entity;

a2. code for calculating the confidence said server has in the instance of the authentication mechanism used;

a3. code for assigning a level of trust that will be associated with said confidence;

a4. code for dynamically calculating using said level of trust what authorization, access and information can be granted to said originating entity regarding said target entity;

b. code for transmitting a response, from said server to said originating entity regardless of the authentication mechanism used, containing a first binding element encrypted using a key derived from a secret stored by said server about the originating entity and its request to access said target entity, and a trust level indicating the level of confidence said server has associated with said originating entity's authentication mechanism instance;

c. code for transmitting a second request that changes and transforms said response containing a first binding element by using knowledge of the same secret of itself, from said originating entity regardless of the authentication mechanism it has used, to said server, thereby requesting a second binding element from said server;

d. code for transmitting a second response containing said second binding element including a unique signature regarding said originating entity and its request to access said target entity to be used by said target entity, from said server to said originating entity;

e. code for transmitting said second response containing said second binding element, from said originating entity to said target entity;

f. code for transmitting a response from said target entity to said originating entity indicating access acceptance of said originating entity by said target entity; and

g. code for creating a secure communication link between said target entity and said originating entity based on said evaluations, assignments and calculations.

11. The medium as set forth in claim **10**, further including code for creating a secure communication link between said server and said originating entity based on said evaluations, assignments and calculations.

12. The medium as set forth in claim **11**, further including code for creating a secure communication link between said target entity and said server based on said evaluations, assignments and calculations.

13. The medium set forth in claim **12** further including:

a. code for providing an event recorder, where said event recorder is authenticated and authorized based on said evaluations, assignments and calculations;

b. code for transmitting chosen events from within said secure communication link between said originating entity and said target entity, said entities authenticated and authorized to access said event recorder based on said evaluations, assignments and calculations to said event recorder;

c. code for transmitting chosen events from said originating entity to said event recorder; and

d. code for transmitting chosen events from said target entity to said event recorder.

14. The medium as set forth in claim **13**, further including at least one of:

a. code for transmitting chosen events from within said secure communication link between said originating entity, authenticated and authorized based on said evaluations, assignments and calculations, and said server to said event recorder; and

b. code for transmitting chosen events from within said secure communication link between said target entity, authenticated and authorized based on said evaluations, assignments and calculations and said server to said event recorder.

15. The medium as set forth in claim **14**, further including:

a. code for monitoring said chosen events for pre-selected types of activities; and

b. code for reporting said events to any said entity authenticated and authorized to receive said events, based on said evaluations, assignments and calculations.

16. The medium set forth in claim **10**, further including code for maintaining objects wished to be held in secure storage associated with said originating entity, said objects selected from the group consisting of authentication, authorization, permission, name/value, credential, client specific, group, group information, group membership, personalization, legacy system access, role based authorization control, and other objects wished to be private, and including:

a. code for storing in said server one or more objects associated with said originating entity, each requiring a sufficient level of trust for assignment;

b. code for sending a request from said target entity to said server for one or more objects regarding said originating entity, which has been authenticated and whose authentication mechanism instance has been assigned a level of trust, from said server;

c. code for selecting from said secure storage, utilizing said level of trust that said server has established for said originating entity's authentication mechanism instance, one or more of said objects associated with said originating entity and only retrieving said objects that do not exceed said level of trust;

d. code for transmitting said selected objects from server to said target entity; and

e. code for utilizing said selected objects to establish the level of authorization granted to said originating entity regarding said target entity.

17. The medium set forth in claim **14**, further including:

a. code for providing a method to monitor the operational characteristics of all links said server has participated in establishing;

b. code for monitoring all communications between said server, said originating entity and said target entity;

c. code for recognizing abnormal characteristics and communications within said communications; and

d. code for reporting of said abnormal characteristics and communications to the event recorder, using said established secure communication link to said event recorder without participating entities being aware that reporting is taking place.

18. The medium set forth in claim **10**, further including code for assigning a time stamp and a nonce value to all communications between said server, said originating entity and said target entity.

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