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(54) SYSTEM AND METHOD TO ESTABLISH AND MAINTAIN CONDITIONAL TRUST BY STATING SIGNAL OF DISTRUST

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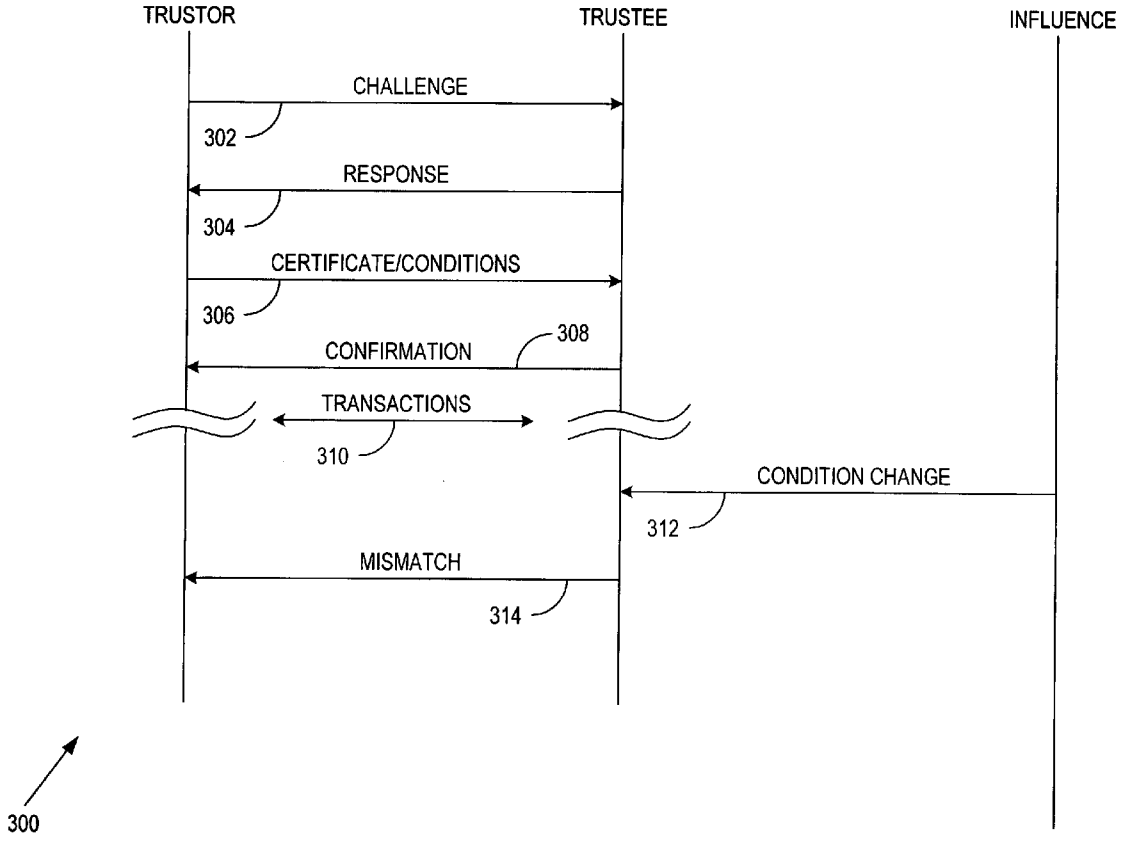
(57) **ABSTRACT**

A system and method is provided that establishes and maintains conditional trust by stating a signal of distrust from a trustee's computing platform to a trustor's computing platform. The trustor attests a trustee at a given time and also sends trust conditions to the trustee upon which the trustor trusts the trustee for some intended purpose. The trust conditions may include restrictions on hardware or software components and any status changes to the hardware or software components. The trustee then monitors the hardware and software components in relation to the trust conditions and reports distrust signals when the trustee's hardware and software configuration no longer matches the trust conditions.



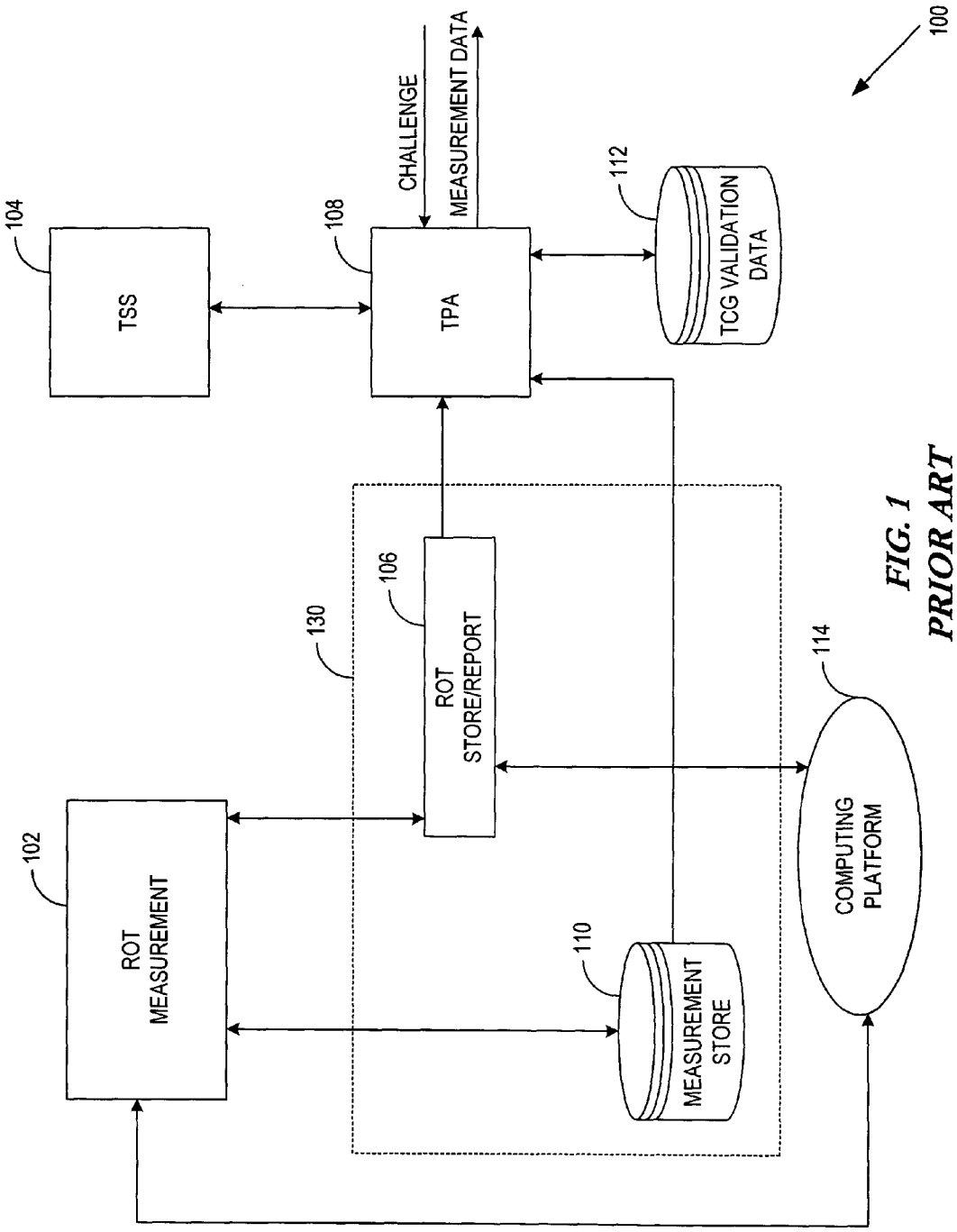


FIG. 1
PRIOR ART

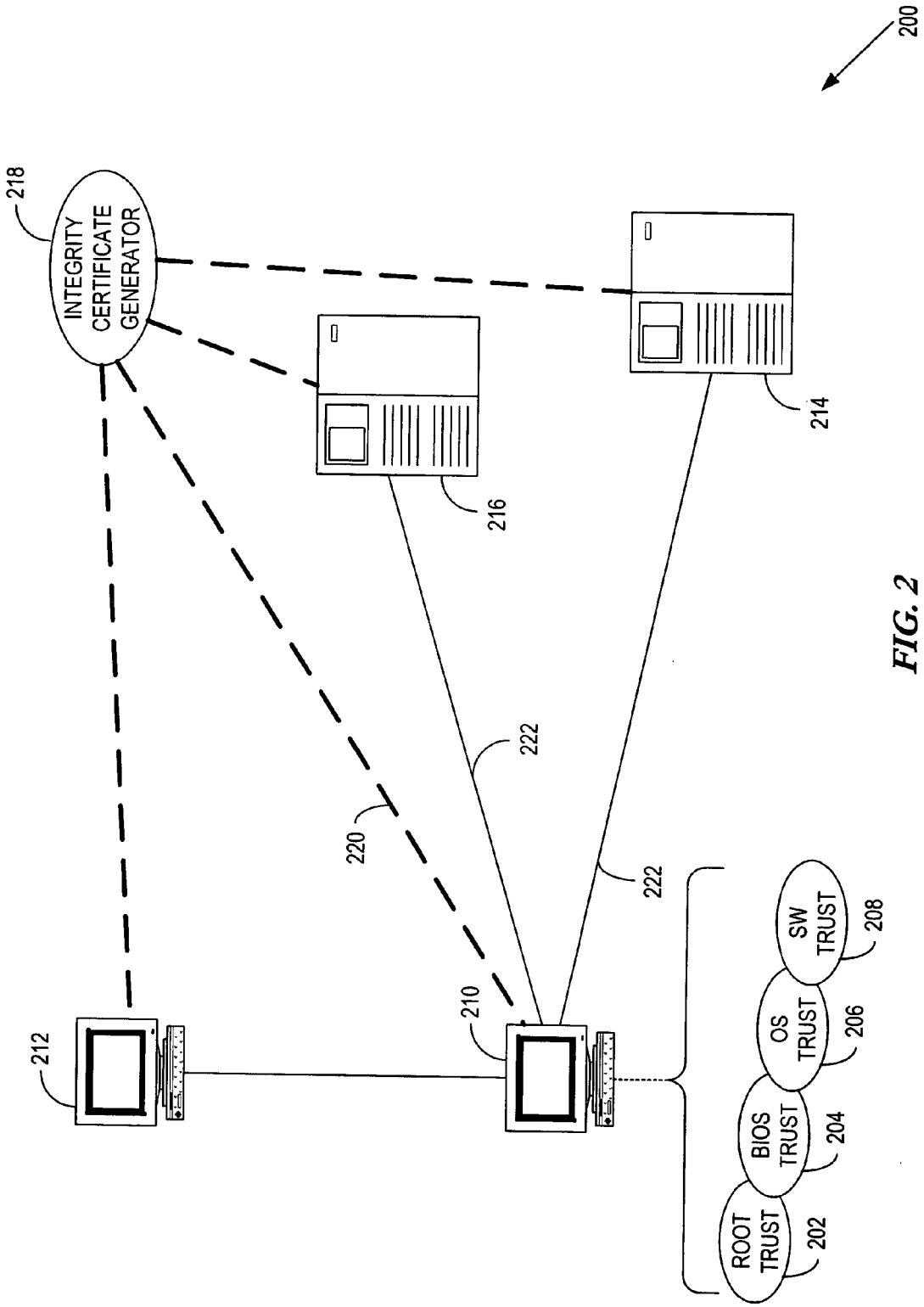

200
218
INTEGRITY CERTIFICATE GENERATOR
214
216
222
220
222
212
210
SW TRUST
208
OS TRUST
206
BIOS TRUST
204
ROOT TRUST
202

FIG. 2

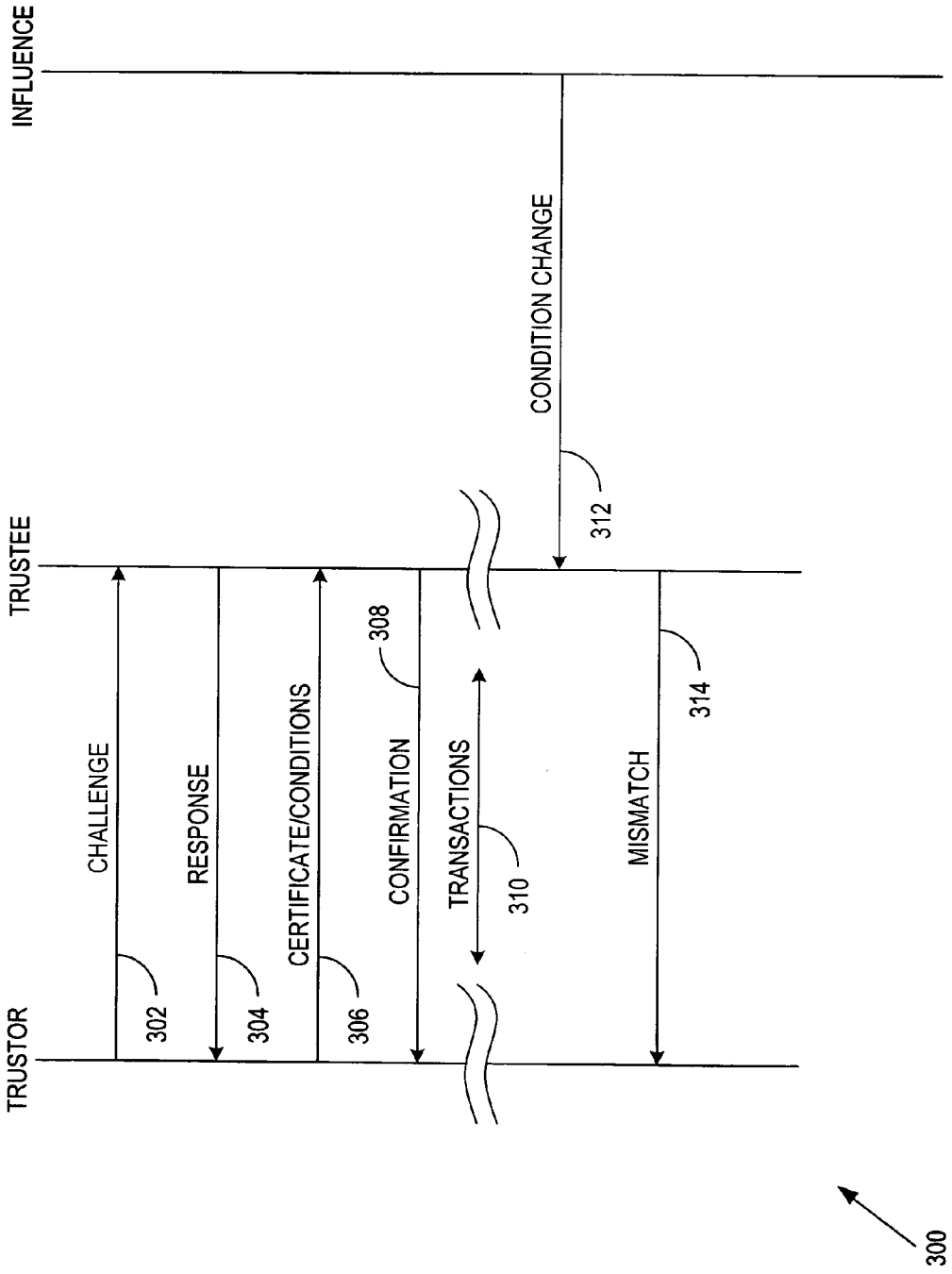

INFLUENCE
TRUSTEE
TRUSTOR
CHALLENGE
RESPONSE
CERTIFICATE/CONDITIONS
CONFIRMATION
TRANSACTIONS
MISMATCH
CONDITION CHANGE
302
304
306
308
310
312
314
300

FIG. 3

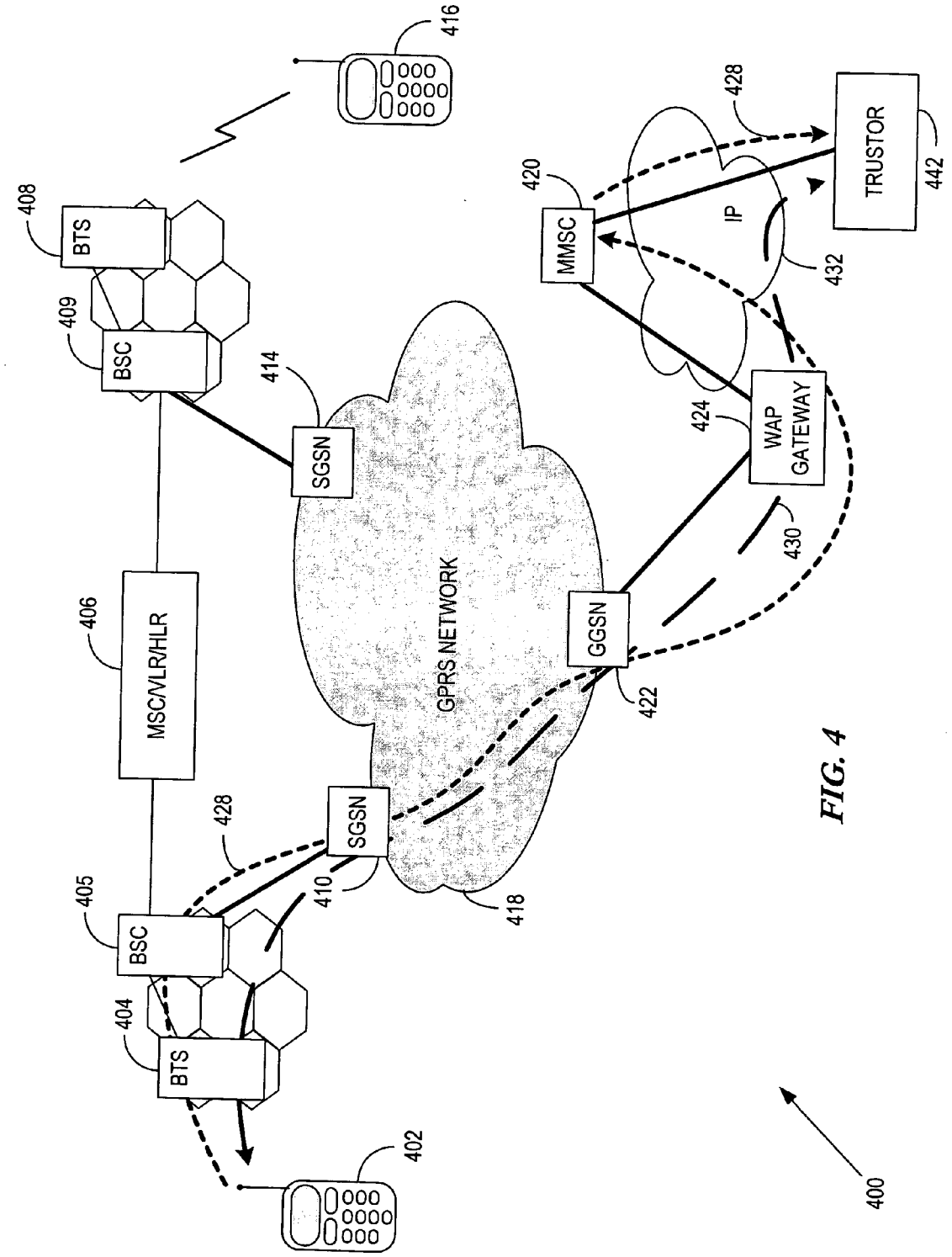

BTS
408
BSC
409
MSC/VLR/HLR
406
BSC
405
BTS
404
402
SGSN
414
SGSN
410
428
GPRS NETWORK
418
GGSN
422
WAP GATEWAY
424
430
MMSC
420
IP
432
428
TRUSTOR
442
416
400

FIG. 4

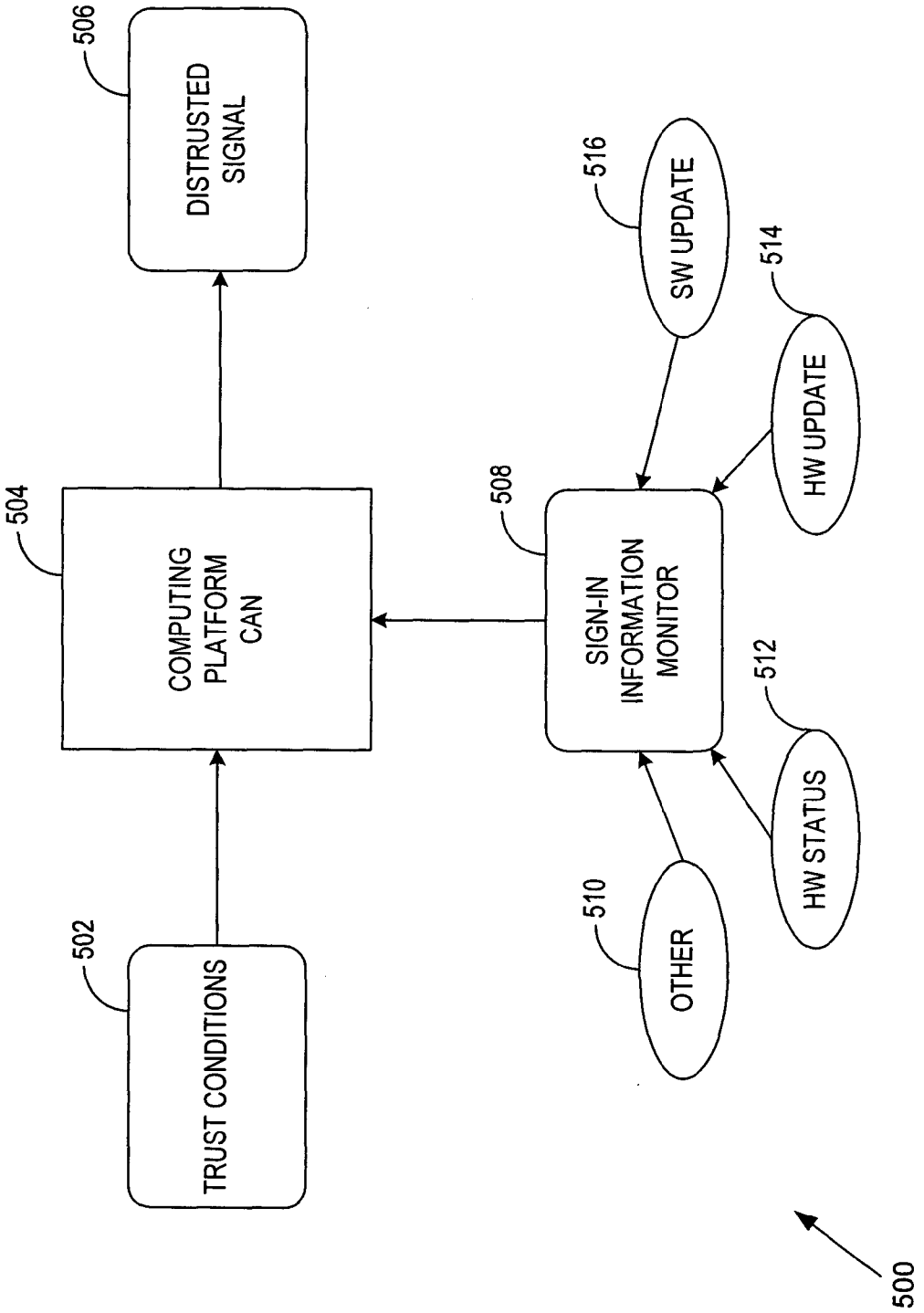

502
TRUST CONDITIONS
504
COMPUTING PLATFORM CAN
506
DISTRUSTED SIGNAL
508
SIGN-IN INFORMATION MONITOR
510
OTHER
512
HW STATUS
514
HW UPDATE
516
SW UPDATE
500

FIG. 5

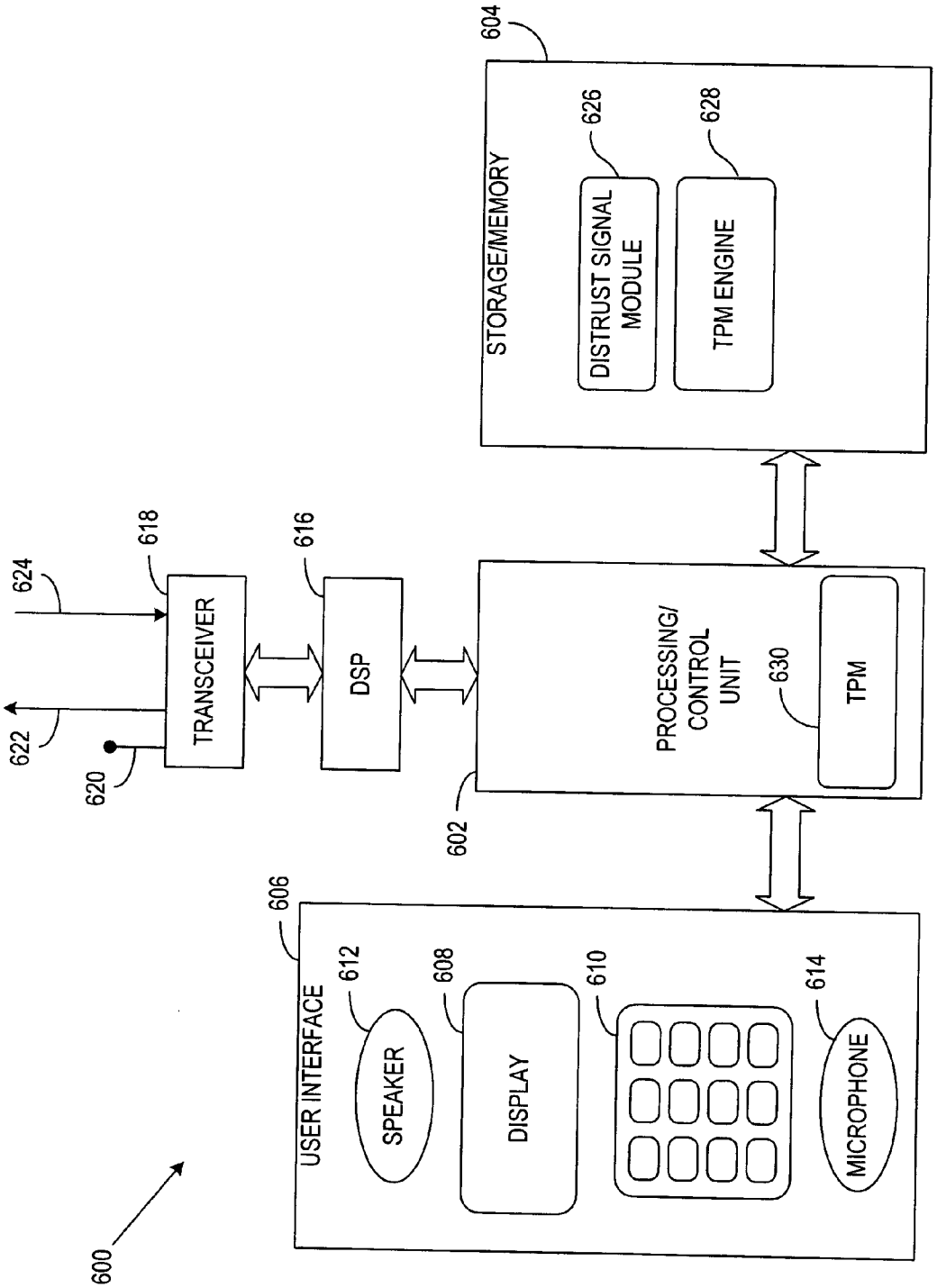

600
606
USER INTERFACE
612
SPEAKER
608
DISPLAY
610
614
MICROPHONE
602
PROCESSING/
CONTROL
UNIT
630
TPM
604
STORAGE/MEMORY
626
DISTRUST SIGNAL
MODULE
628
TPM ENGINE
616
DSP
618
TRANSCEIVER
624
622
620

FIG. 6

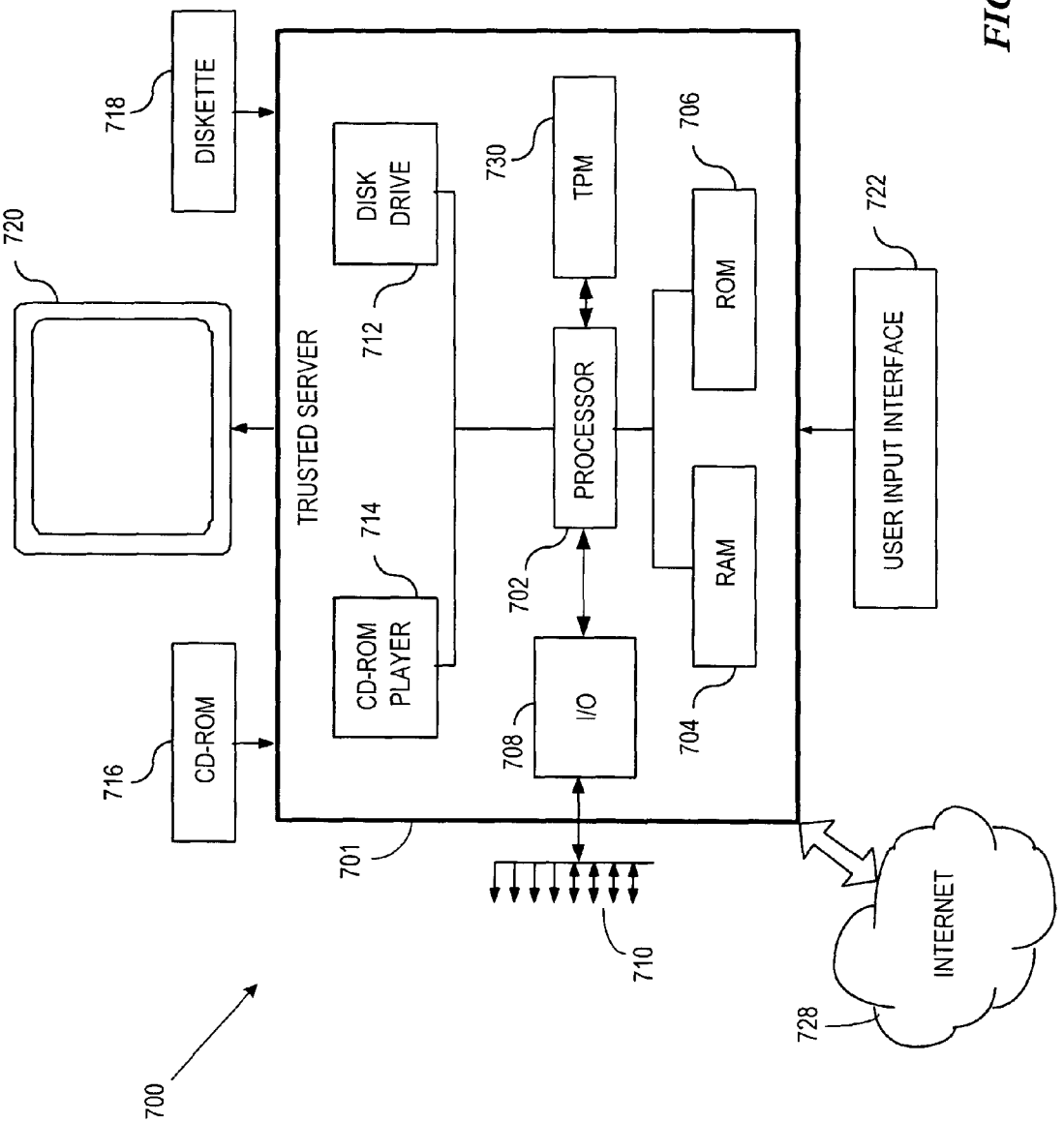

700
720
718
DISKETTE
716
CD-ROM
TRUSTED SERVER
701
DISK DRIVE
712
CD-ROM PLAYER
714
730
TPM
PROCESSOR
702
I/O
708
710
706
ROM
RAM
704
722
USER INPUT INTERFACE
INTERNET
728

FIG. 7

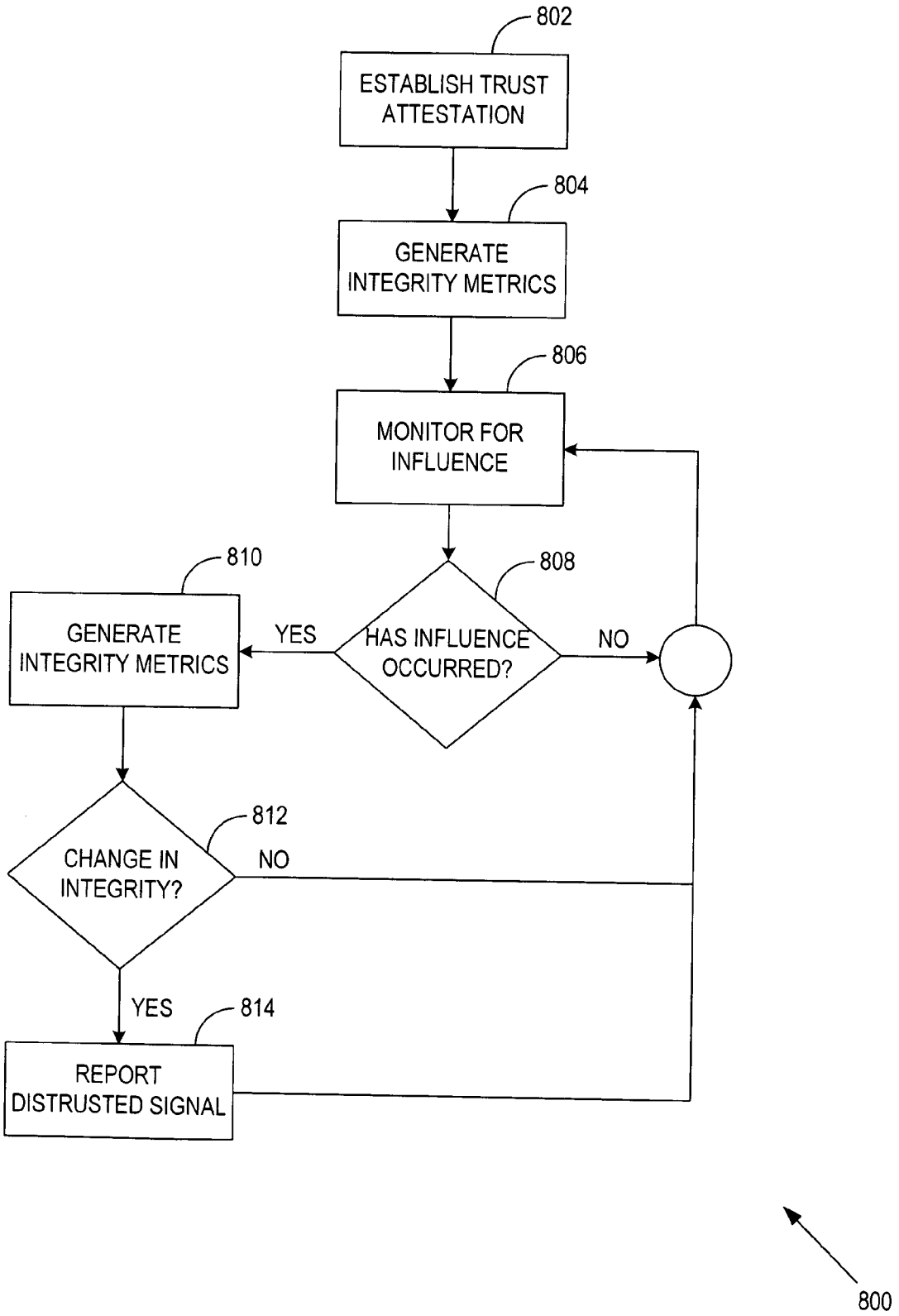

802
ESTABLISH TRUST ATTESTATION
804
GENERATE INTEGRITY METRICS
806
MONITOR FOR INFLUENCE
808
HAS INFLUENCE OCCURRED?
YES
NO
810
GENERATE INTEGRITY METRICS
812
CHANGE IN INTEGRITY?
NO
YES
814
REPORT DISTRUSTED SIGNAL
800

FIG. 8

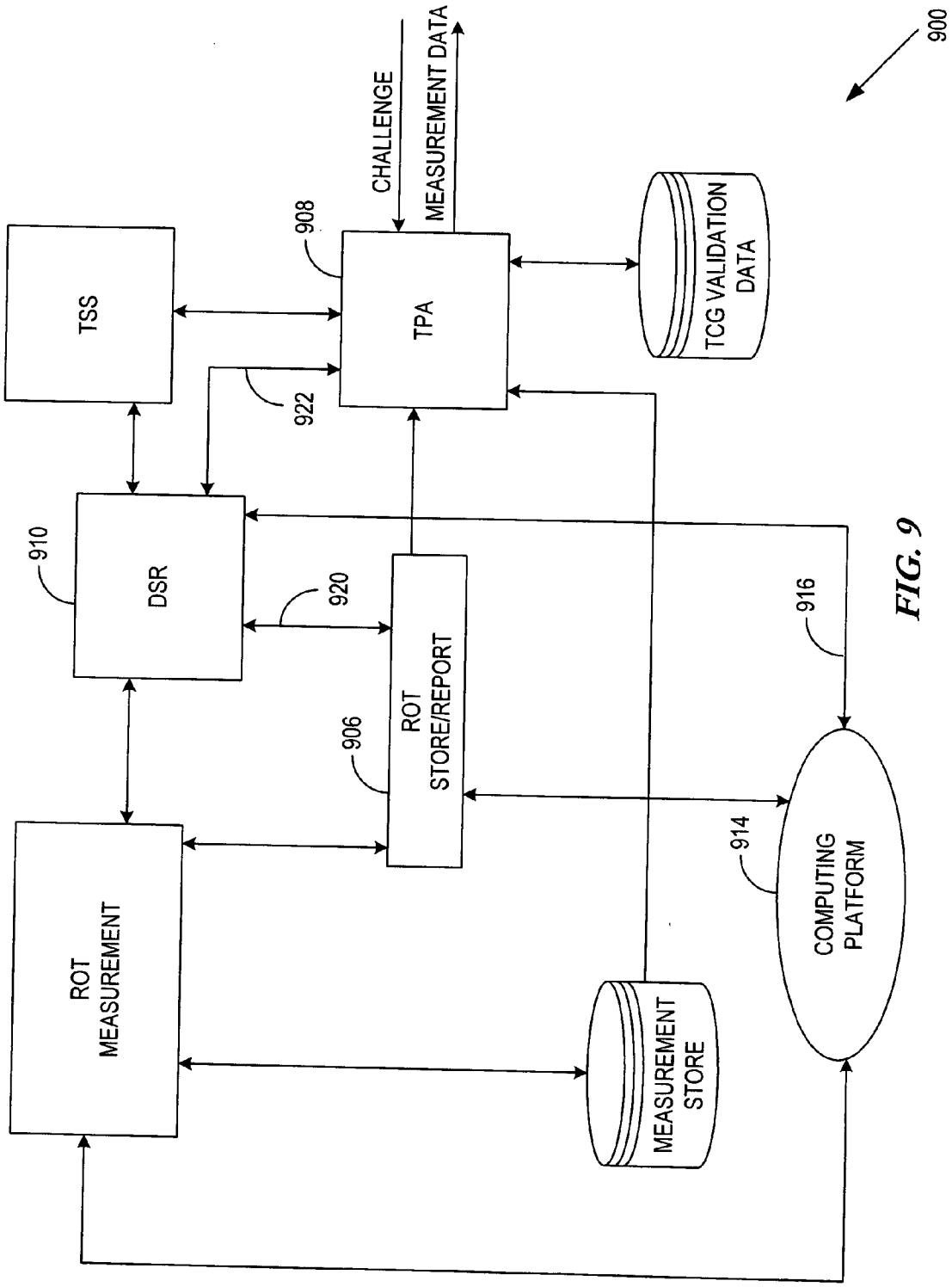

900
TSS
908
CHALLENGE
MEASUREMENT DATA
TPA
TCG VALIDATION DATA
922
910
DSR
920
ROT STORE/REPORT
906
916
ROT MEASUREMENT
914
COMPUTING PLATFORM
MEASUREMENT STORE

FIG. 9

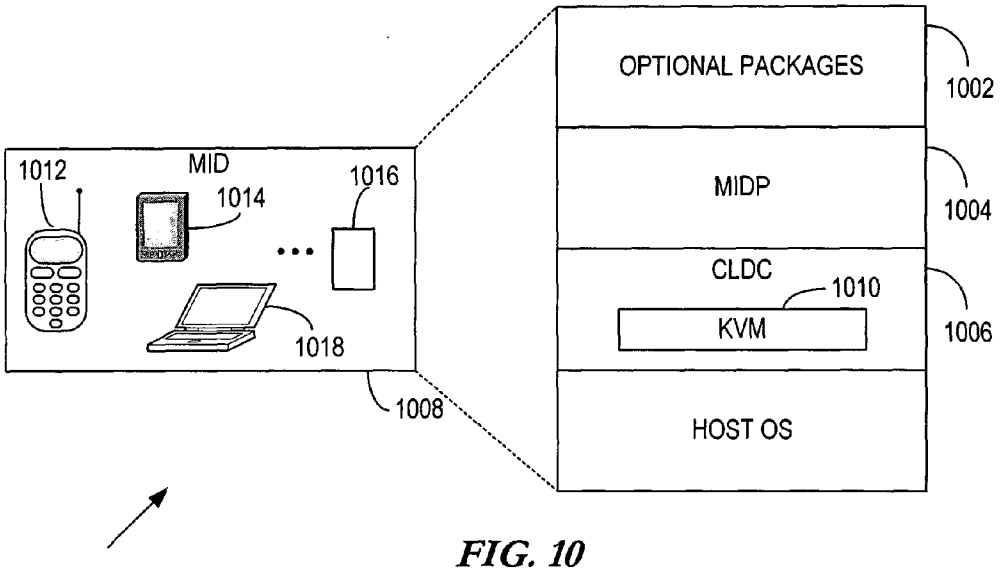

OPTIONAL PACKAGES
1002
MIDP
1004
CLDC
1010
KVM
1006
HOST OS
1012
MID
1014
1016
1018
1008
1000

FIG. 10

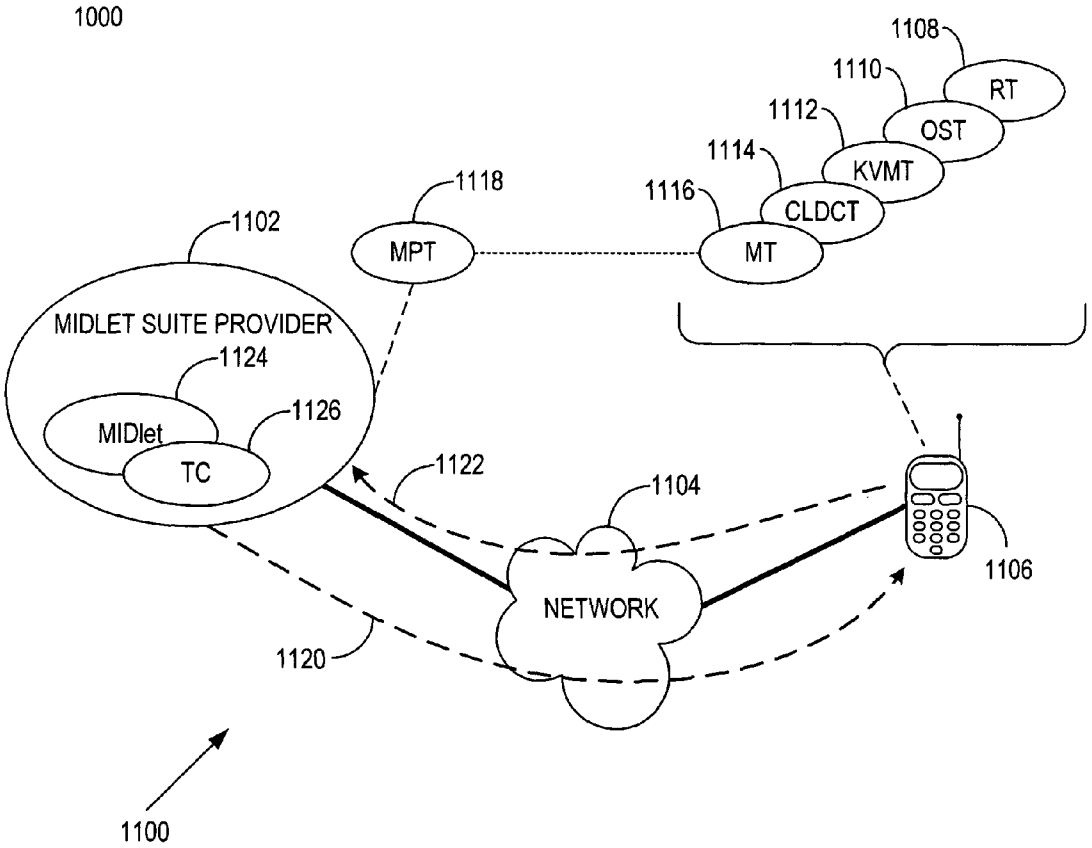

1108
RT
1110
OST
1112
KVMT
1114
CLDCT
1116
MT
1118
MPT
1102
MIDLET SUITE PROVIDER
1124
MIDlet
1126
TC
1122
1104
NETWORK
1106
1120
1100

FIG. 11

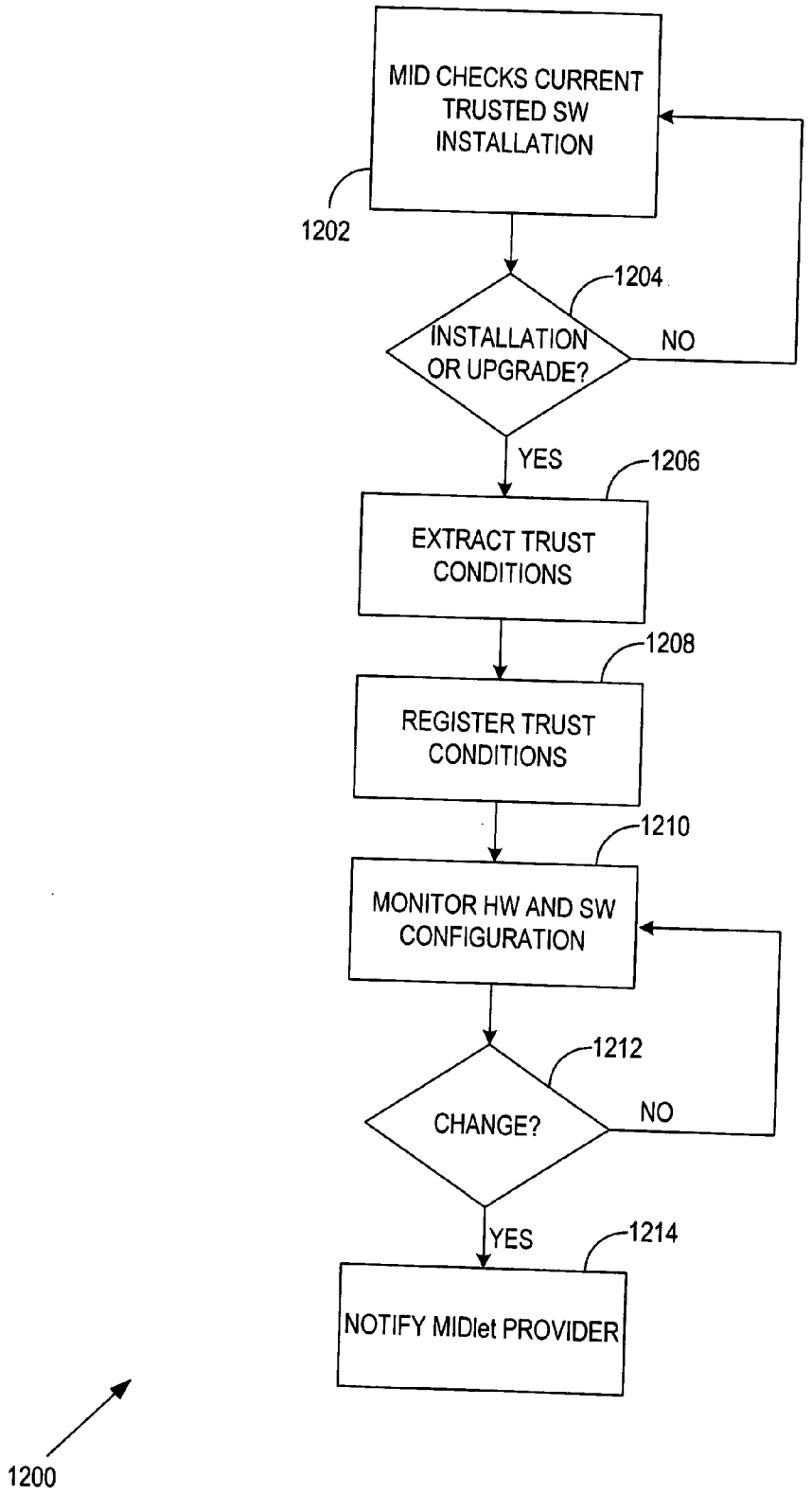

MID CHECKS CURRENT TRUSTED SW INSTALLATION
1202
1204
INSTALLATION OR UPGRADE?
NO
YES
1206
EXTRACT TRUST CONDITIONS
1208
REGISTER TRUST CONDITIONS
1210
MONITOR HW AND SW CONFIGURATION
1212
CHANGE?
NO
YES
1214
NOTIFY MIDlet PROVIDER
1200

FIG. 12

SYSTEM AND METHOD TO ESTABLISH AND MAINTAIN CONDITIONAL TRUST BY STATING SIGNAL OF DISTRUST

FIELD OF THE INVENTION

[0001] This invention relates in general to trusted platforms, and more particularly, to trusted platforms capable of generating distrust signals when the trusted platform's current configuration state does not match a set of trusted conditions.

BACKGROUND OF THE INVENTION

[0002] Trust is a crucial aspect in e-commerce, communications, and related applications. Since e-commerce is implemented using both mobile and land based computing platforms, enhancing trust in these computing platforms is a fundamental issue and is of growing importance in the computing industry.

[0003] The Trusted Computing Platform Alliance (TCPA) formed in 1999 by Intel, HP/Compaq, IBM, Microsoft, and other companies, proposes a new computing platform for this century that will initially provide improved trust in the Personal Computer (PC) platform with eventual trust provided by the Trusted Mobile Computing Platform (TMCP). The TCPA promotes the concept of a trusted subsystem and chains of trust between such subsystems, so as to provide the basic building blocks for e-Commerce.

[0004] Originating from the TCPA, the Trusted Computing Group (TCG) focuses on open standards to enhance the overall security and trustworthiness of a variety of computing devices. One such standard is the Trusted Mobile Computing Platform (TMCP) that includes standards for trusted computing using mobile terminals. Ongoing efforts by the TCG continue to focus on the impact of TCPA on mobile commerce because the TCPA was initially intended for land based computing systems such as the PC.

[0005] The Trusted Platform (TP), as defined by the TCPA, is a platform that behaves the way it is expected to behave for its intended purpose. The TCPA definition of a trusted system is a system that always behaves in the expected manner for the intended purpose. The trust of a TCPA computing platform is built upon a root trust, which is convinced by sound existing technologies, including both hardware and software technologies. The root trust is realized through the TCPA subsystem, which typically consists of a root of trust for measuring integrity metrics; a Trusted Platform Module (TPM); and other Trusted Support Systems (TSS). The TCPA subsystem supports two roots of trust: the root of trust for measuring integrity metrics and the root of trust for storing and reporting integrity metrics, which is realized by the TPM.

[0006] The way in which a remote computing platform can be trusted is as follows. First, integrity metrics are queried from the platform, which are digitally signed by the trusted component of that platform. Second, the integrity metrics are compared with expected values that represent components that are trusted enough to perform the intended purpose. Third, if the compared values match the expected values, trusted interaction with the remote computing platform may be commenced. Anomalous metrics indicate that the platform is not operating as expected and further correspondence with the platform should be considered very carefully.

[0007] The TCPA strives to provide authenticity, integrity, and privacy so that: 1.) users are confident that they know to whom and to what entity they are communicating; 2.) transfer of information occurs accurately; and 3.) potential snoopers cannot invade the privacy of the system, message, or transaction. Trust, however, has several complicated and multi-dimensional concepts associated with it. Trust, for example, is dynamic because the level of trust that is considered sufficient varies for each individual and it varies over time. Trust is affected by many factors that are both subjective and objective, making a correct evaluation of trust difficult indeed.

[0008] Additionally, trust is not always transitive, meaning that: if entity A trusts entity B; and entity B trusts entity C; trust between entity A and C is not always conferred, although it may be in certain situations. Trust has varying degrees and scope, where entities typically develop trust for each other for their intended purpose, but that trust is not always transferred to other interactions between the entities.

[0009] Since trust is dynamic, it is impossible to provide a static/absolute trust solution. Accordingly, one disadvantage of the current TCPA paradigm, is that it does not provide a dynamic solution and is thus unable to tailor its protection for the changeable trust component. The static nature of the current TCPA solution, therefore, may cause a waste of resources and unnecessary attestation when the trust level is actually very high, while failing to satisfy security requirements for transactions when the trust level is actually very low.

[0010] Through checking of the integrity metrics, the root trust may trust the Basic Input Output System (BIOS), the BIOS may trust the Operating System (OS), the OS may trust the software application, and the software application may trust other remote systems. The chain of trust, however, does not necessarily remain intact for an extended length of time, nor does it remain in tact after hardware or software configuration changes. Accordingly, the trust chain is built up during system boot, which means that the OS can only verify its trust for previously identified configurations, thus failing to verify trust for any newly added hardware or software components.

[0011] Generally speaking, the TCPA fails to provide a model whereby integrity metrics may be trusted remotely. In particular, software applications may be able to record the challenge requests and their corresponding correct integrity metrics and thus may be able to replay the integrity metrics during subsequent integrity metrics requests. Once the recordings are complete, Denial of Service (DoS) attacks may also be implemented whereby TCPA compliant systems may be inundated with challenge requests and effectively crippled due to the sheer quantity of processing required by the challenge requests. One possible solution for these attacks is to time stamp the integrity metrics, however, a remote challenge procedure is easily simulated whereby signed integrity metrics may be obtained with a valid time stamp and subsequently replayed. Other solutions involve using serial numbers to identify the signed integrity metrics, the use of short-life cycle certificates or frequent polled metric checks, but each method is either non-economic, non-feasible, or provides limited attack protection.

[0012] Another area of deficiency within the trusted computing environment is exhibited by Java-2 Platform Micro

Edition (J2ME) applications. Although certain security provisions are provided by the security and trust services Application Programming Interface (API) for J2ME, i.e., Java Specification Request (JSR) 177, it fails in many respects to provide adequately trusted operations.

[0013] In order to perform trusted operations, J2ME applications need to rely on the security services provided in a security element to ensure that, for example, the cryptographic keys are stored securely and that the cryptographic computations are performed securely. The proposed JSR 177 APIs establish a Java programming model for accessing the features of a security element, however, the trusted operation issue cannot be solved by JSR 177 because it simply focuses on MIDlet interaction with the security element, such as a smart card. The JSR 177 defines a collection of APIs that provide security services to J2ME enabled devices, i.e., it provides an access model that enables applications running on J2ME enabled devices to communicate with a smart card inserted in the device, but it fails to consider that the mobile code may be modified from its original state and may no longer be trusted. Digital signatures and Digital Rights Management (DRM) procedures are currently unable to solve the problem.

[0014] Accordingly, there is a need in the computing/communications industry for a system and method that implements trust based on the current TCPA/TCG technology while improving upon its propensity to counteract spoofing attacks and its ability to maintain trust.

[0015] Additionally, there is a need to provide a self-regulating mechanism that maintains trust without the need for unnecessary communication and computation.

SUMMARY OF THE INVENTION

[0016] To overcome limitations in the prior art, and to overcome other limitations that will become apparent upon reading and understanding the present specification, the present invention discloses a system and method for establishing and maintaining conditional trust between a trustee and a trustor by stating distrust signals from a trustee's terminal to a trustor's terminal.

[0017] In accordance with one embodiment of the invention, a method for establishing and maintaining conditional trust between a trustee and a trustor is provided. The method comprises generating metrics by a trustor that represents a trusted condition, comparing the generated metrics to current metrics of a trustee, and issuing a distrust signal by the trustee in response to a mismatch between the generated metrics of the trustor and the current metrics of the trustee.

[0018] In accordance with another embodiment of the invention, a trusted computing system is provided. The trusted computing system comprises a trustor terminal coupled to provide a trust condition to define a configuration state, and a trustee terminal coupled to receive the trust condition and coupled to provide attestation of the configuration state. The trustee terminal provides a distrust signal to the trustor terminal when the configuration state does not match the trusted condition.

[0019] In accordance with another embodiment of the invention, a mobile terminal wirelessly coupled to a network which includes a network element capable of providing a trusted condition is provided. The mobile terminal comprises a memory capable of storing at least a distrust signal module and a Trusted Platform Module (TPM) engine, a processor coupled to the memory and configured by the TPM engine to enable a configuration attestation with the network element, and a transceiver configured to facilitate a trusted condition exchange with the network element. The processor is configured by the distrust signal module to provide a distrust signal when the configuration does not match the trusted condition.

[0020] In accordance with another embodiment of the invention, a computer-readable medium having instructions stored thereon which are executable by a mobile terminal for maintaining a trusted system configuration is provided. The instructions perform steps comprising receiving trusted conditions representing a required system configuration of the mobile terminal, generating integrity metrics representative of a current system configuration of the mobile terminal, and supplying a distrust signal representative of a difference between the required system configuration and the current system configuration.

[0021] In accordance with another embodiment of the invention, a server within a network used to establish a trusted exchange with a mobile terminal is provided. The server comprises means for providing a trusted condition to define a configuration state of the mobile terminal, and means for receiving a distrust signal from the mobile terminal. The distrust signal is indicative of a difference between a current configuration state of the mobile terminal and the trusted condition.

[0022] In accordance with another embodiment of the invention, a computer-readable medium having instructions stored thereon which are executable by a server for facilitating trusted network computing is provided. The instructions perform steps comprising providing a trusted condition to define a configuration state of a trustee terminal, and receiving a distrust signal from the trustee terminal. The distrust signal is indicative of a difference between a current configuration state of the trustee terminal and the trusted condition.

[0023] In accordance with another embodiment of the invention, a distrust signal reporting system is provided. The distrust signal reporting system comprises a computing platform CAN configured to receive trust conditions from a trustor that defines a trusted configuration state, and an information monitor coupled to the computing platform CAN and configured to monitor configuration and status signals from a trustee platform and to report a configuration state of the trustee platform to the computing platform. The computing platform CAN generates a distrust signal when the configuration state of the trustee platform does not match the trusted configuration state.

[0024] In accordance with another embodiment of the invention, a trusted platform system is provided. The trusted platform system comprises a trustee computing platform configured to provide configuration and status signals relating to the trustee computing platform, a Root of Trust (ROT) measurement module coupled to the trustee computing platform and configured to measure integrity metrics associated with the trustee computing platform in response to the configuration and status signals, a ROT store module coupled to receive the integrity measurement metrics from the ROT measurement module, and a Trusted Platform

Agent (TPA) coupled to receive trust conditions and challenges from a trustor and coupled to provide measurement data in response to the challenges. The trusted platform system further comprises a distrust signal reporting module. The distrust signal reporting module includes a computing platform CAN coupled to the TPA to receive the trust conditions, where the trust conditions define a trusted configuration state, and an information monitor coupled to the computing platform CAN and configured to monitor the configuration and status signals from the trustee computing platform and to report a configuration state of the trustee computing platform to the computing platform CAN. The computing platform CAN checks the trust conditions against the configuration state of the trustee computing platform and generates a distrust signal to the TPA when the configuration state of the trustee platform does not match the trusted configuration state. The TPA is further responsible for the delivery of the distrust signal to the trustor's platform.

[0025] In accordance with another embodiment of the invention, a method of providing conditional trust between a MIDlet provider and a Mobile Information Device (MID) is provided. The method comprises attaching trust conditions to a MIDlet suite contained within the MIDlet provider, downloading the MIDlet suite and attached trust conditions to the MID, checking the trust conditions against a configuration of the MID to determine a difference between the trust conditions and the configuration, and reporting the difference to the MIDlet provider.

[0026] In accordance with another embodiment of the invention, a method for establishing and maintaining conditional trust between a trustee and a trustor is provided. The method comprises generating metrics by the trustor that represents a trusted condition, sending the trusted condition to the trustee for a conditional trust reference, generating metrics by the trustee according to the conditional trust reference at the trust attestation stage for an intended purpose, registering the conditional trust reference at a trusted computing platform CAN within the trustee, checking the trustee generated metrics against current metrics of the trustee according to the conditional trust reference, and issuing a distrust signal by the trustee in response to a mismatch between the conditional trust reference and the current metrics of the trustee.

[0027] In accordance with another embodiment of the invention, a method of providing conditional trust between a content provider and a device is provided. The method comprises attaching trust conditions to content contained within the content provider, downloading the content and attached trust conditions to the device, checking the trust conditions against a configuration of the device to determine a difference between the trust conditions and the configuration, and reporting the difference to the content provider.

[0028] These and various other advantages and features of novelty which characterize the invention are pointed out with greater particularity in the claims annexed hereto and form a part hereof. However, for a better understanding of the invention, its advantages, and the objects obtained by its use, reference should be made to the drawings which form a further part hereof, and to accompanying descriptive matter, in which there are illustrated and described specific examples of a system and method in accordance with the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] The invention is described in connection with the embodiments illustrated in the following diagrams.

[0030] **FIG. 1** illustrates a Trusted Platform Subsystem (TPS) in accordance with the prior art;

[0031] **FIG. 2** illustrates an exemplary network of trusted platforms and challenging entities according to the present invention;

[0032] **FIG. 3** illustrates an exemplary message flow according to the present invention;

[0033] **FIG. 4** illustrates an exemplary network in which the principles of the present invention may be practiced;

[0034] **FIG. 5** illustrates an exemplary distrust signal reporting system in accordance with the present invention;

[0035] **FIG. 6** illustrates a representative mobile computing arrangement in accordance with the present invention;

[0036] **FIG. 7** is a representative computing system according to the present invention;

[0037] **FIG. 8** illustrates a conditional trust procedure in accordance with the present invention;

[0038] **FIG. 9** illustrates an exemplary block diagram of an improved trust platform system in accordance with the present invention;

[0039] **FIG. 10** illustrates a typical Java 2 Platform Micro-Edition stack;

[0040] **FIG. 11** illustrates a MIDlet suite download scenario and associated trust condition warning system in accordance with the present invention; and

[0041] **FIG. 12** illustrates an exemplary flow diagram of a MIDlet suite installation/upgrade method to establish conditional trust in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0042] A portion of the disclosure of this patent document contains material which is subject to copyright protection. The copyright owner has no objection to the reproduction of the patent document or the patent disclosure, as it appears in the Patent and Trademark Office patent file or records, but otherwise reserves all copyrights and associated copyright ownership privileges.

[0043] In the following description of the exemplary embodiment, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration various embodiments in which the invention may be practiced. It is to be understood that other embodiments may be utilized, as structural and operational changes may be made without departing from the scope of the present invention.

[0044] Generally, the present invention is directed to a method and system that defends against any malicious behavior occurring between a trustor and a trustee after the trustee has gained the trust of the trustor. The present invention matches up trust characteristics completely by establishing and maintaining the trust to the trustee in terms of some intended purpose under preferred conditions speci-

fied by the trustor ahead of time. In so doing, the fundamental characteristic of trust may be supported.

[0045] Open platforms are general purpose computing platforms where there is no a priori trust established between the hardware of the platform and a third party that could be used to prove the functionality of the platform. Examples of open platforms include workstations, mainframes, Personal Digital Assistants (PDA), and PCs. Open platforms possess many practical benefits over closed platforms, but unfortunately, a remote party cannot make any assumptions about how that platform will behave or misbehave.

[0046] Closed platforms are special purpose computing devices that interact with the user via a restricted interface, e.g., automated tellers, game consoles, and satellite receivers. Closed platforms contain mechanisms that restrict modifications to its software. A closed platform can authenticate itself as an authorized platform to a remote party using a secret key embedded in the platform during manufacturing. Closed platforms rely on hardware tamper resistance to protect the embedded secret key and ensure well-behaved operation, but severely limit flexibility of applications.

[0047] Trusted platforms, on the other hand, provide the best properties of open and closed platforms. As with open platforms, trusted platforms allow applications from many different sources to run on the same platform. As with a closed platform, remote parties can determine what software is running on a platform and thus determine whether to expect the platform to be well behaved.

[0048] Trusted Platform Subsystem (TPS) **100** according to the prior art is illustrated in **FIG. 1**. TPS **100**, among other things, enables an entity to determine the state of the hardware and software environment in TPS **100** and to seal data to a particular configuration within TPS **100**. The entity deduces whether the state of the computing environment in TPS **100** is acceptable and performs some transaction with TPS **100**. If the transaction involves sensitive data that must be stored on TPS **100**, the entity can ensure that the data is held in a confidential format unless the state of the computing environment in TPS **100** is acceptable to the entity.

[0049] TSS **104** provides mechanisms for cryptographically reporting the current hardware and software configuration of computing platform **114** to local and remote challengers. TSS **104** also provides a limited protected storage capability, which allows the owner of TPS **100** to store an acceptable platform configuration, biometric data, or other data that is available early during system boot. System firmware or other software may use this storage capability to name users who are qualified to log on, or to store acceptable boot configurations. TSS **104** also provides a facility whereby platform software or firmware may store secrets that are accessible only when the platform is in a defined configuration, a mechanism known as sealing.

[0050] TPS **100** provides reliable information via signal MEASUREMENT DATA to enable the challenging entity to deduce the hardware/software environment in TPS **100**. At the same time, TPS **100** provides a means to encrypt cryptographic keys and to state the software environment that must be in place before the keys can be encrypted. Both functions of TPS **100** require integrity metrics, which consist of data reflecting the integrity of the configured state of TPS **100**. Both functions require two roots of trust: Root of Trust (ROT) **102** for measuring integrity metrics; and ROT **106** for storing and reporting integrity metrics. ROT **102** measures certain platform characteristics, logs the measurement data into measurement store **110**, and stores the final result in ROT **106**.

[0051] When an integrity challenge, e.g., CHALLENGE, is received, Trusted Platform Agent (TPA) **108** gathers the final results from ROT **106**, the log of measurement data from trusted platform measurement store **110**, and Trusted Computing Group (TCG) validation data **112** that states the values that the measurements should produce in a platform that is working correctly. TPA **108** then sends the gathered data, e.g., MEASUREMENT DATA, to the challenging entity, who then uses the data to check that it is consistent with the final results and then compares the data with the TCG validation data. This comparison allows the challenging entity to deduce the configured state of TPS **100** and consequently decide whether it is satisfied to trust TPS **100** for its intended purpose.

[0052] Once the challenging entity has determined that TPS **100** can be trusted, the challenging entity can use TPM **130** to store keys alongside stated values of integrity metrics, such that TPM **130** will not release the keys unless the current measured values of integrity metric match the stated values of integrity metric. Both ROT **102** and **106** and Trusted Platform Support Services (TSS) **104** are implemented in ways that enable confidence in their correct operation in all circumstances of interest. The implementation of ROT **102** typically varies depending upon the type of platform that it resides upon, e.g., PC, server, or mobile terminal. TPM **130** is defined as the set of all trusted capabilities aside from ROT **102** because these are independent of the type of platform used.

[0053] Each entry in the log inside measurement store **110** of TPM **130** contains a description of a measured entity plus an appropriate integrity metric that has been recorded inside TPM **130**. The log can be used to reproduce the value of each sequence of integrity metrics inside TPM **130**. If the log and the TPM are consistent and if the TPM is trustworthy, the log can also be trusted. If the values derived from the log and the values reported by the TPM are the same, the log is presumed to be an accurate record of the steps involved in building the software environment on computing platform **114**. Any difference between the values derived from the log and the values reported by the TPM indicate an undesirable inconsistency in the configuration state of computing platform **114**.

[0054] A large number of integrity metrics may be measured that reflect the configuration state of computing platform **114**, whereby a particular metric may change with time, thus requiring a new value to be stored. TPS **100** provides a way to store sequences of integrity metrics, rather than overwrite old metric values with newly computed values. Values of integrity metrics are not stored within TPS **100**, but are rather appended to a sequence. The new value of an integrity metric is concatenated to the existing value of the sequence, a digest is computed for the concatenation, and the digest is then used as the new representation of the sequence. In this way, one or more sequences may be used to represent an arbitrary number of integrity metrics and their updates.

[0055] An entity seeking to know the state of the computing environment inside TPS **100** depends critically on the

value of the integrity metrics. The integrity metrics enable an entity to determine the consistency of the measurement information and to compare the actual and expected status of the platform. The integrity metrics themselves, therefore, must be reported by a trusted mechanism, i.e., TPM **130**. TPM **130** proclaims its trustworthiness by signing data using one of its identities and conventional cryptographic techniques. The signature key is known only to TPM **130** and is the private key of a key pair. The corresponding public key is an identity key, since it is a cryptographic value by which TPM **130** is known, therefore, the public key is part of an identity of TPM **130**.

[**0056**] TCPA compliant system **200** of **FIG. 2** illustrates an exemplary network of trusted platforms and challenging entities according to the present invention. Layers **202-208** of workstation **210** represent a trust chain that is specified by the TCPA. The TCPA provides stronger authentication of platforms, e.g., workstations **212** and **210**, and enhances the integrity of internal and external networks, such as for example, Enterprise TCPA compliant system **216** and e-Business TCPA compliant system **214**.

[**0057**] Root trust **202** is realized through the TCPA subsystem, which typically consists of a root trust for measuring integrity metrics, a TPM, and a TSS. The integrity metrics consists of data that reflects the integrity of the hardware/software state of the trusted platform. The TPM is generally implemented using an Integrated Circuit (IC) that is internal to workstations **212** and **210**. When power is applied, the TPM IC takes charge by first checking the boot Read Only Memory (ROM) that it expects, executes it, and then measures the state of the machine against a known safe metric to establish BIOS trust **204**. Once BIOS trust **204** has been verified, Operating System (OS) trust **206** is established by first checking the OS loader, which is responsible for loading system Software (SW) executables and then checks the OS kernel to establish OS trust **206**. The OS kernel then checks a list of legitimate SW to create SW trust **208**, which then uses the OS resources to authenticate local and remote data. As can be seen, the TCPA extends the trust based on root trust **202** by setting up trust chain **202-208**. Once the TPM IC knows the metric of one item, it can expand the list of trusted items by checking the metric of each layer. In this way, the TPM IC can expand its trust boundary on verified hardware and software. The TCPA makes use of integrity metrics to inspect the trust chain by its previous chain and detects the misbehavior of the chain after root trust **202** to include the behavior of remote parties.

[**0058**] The process of dynamically establishing that a platform conforms to the specification expected by a remote party is done through a process called attestation. Attestation consists of several steps of cryptographic authentication by which the specification for each layer of the platform is checked from the hardware up to the operating system and application code. Attestation is then extended to remote workstations, PCs, and other network entities to expand the trust boundary. At a high level, the steps of attestation are as follows.

[**0059**] A hardware platform, e.g., workstation **210**, has a signing key, K_{sign}, and a public key certificate, C_{hw}, for this key that is issued by, for example, integrity certificate generator **218** via path **220**. When an application, e.g., application A, is executed on workstation **210** for example, it generates a public/private key pair, PK_A/SK_A. Next, the application requests the workstation to certify its public key PK_A, to which the workstation uses its signing key K_{sign} to generate a certificate for PK_A, which is denoted C_A. Along with standard certificate fields, the certificate C_A contains the hash of the executable image of the application A. The signed certificate C_A is then returned to the application.

[**0060**] When the application wants to attest its validity to a remote server, e.g., Enterprise TCPA compliant system **216** or e-Business TCPA compliant system **214**, it sends the integrity metrics, e.g., certificate chain (C_{hw},C_A), to the remote server as part of the response to the challenge depicted in path **222**. The server then checks two things: the signatures on both certificates are valid and that C_{hw} is not revoked; and that the application hash embedded in C_A is on the server's list of applications it trusts. At this point, the server is assured that C_A comes from an application that it trusts. The application is now able to authenticate itself by proving its knowledge of private key SK_A.

[**0061**] TCPA compliant system **200** adds special value such as authentication, integrity and privacy to a Business-to-Business (B2B) Public Key Infrastructure (PKI) deployment. In a buyer/supplier model, for example, TCPA capability enables a buyer and a supplier to issue a challenge, e.g., **222**, to the buyer/supplier platform to determine that it is a trusted system. After convincing the mutual trust between the supplier and the buyer, both of the transaction parties can conduct business remotely. TCPA compliant system **200** may also support an Enterprise virtual private network, in order to enable access by employees located in remote sites. The trust is built by obtaining integrity metrics in the remote platform, securely storing these metrics in the remote platform, and then ensuring the report of metrics from the remote platform is secure through attestation.

[**0062**] Attestation, however, only allows a remote party to ascertain what configuration was launched on a particular platform and establishes a session key for future interaction with that configuration on that particular platform. This does not provide trustworthiness in the usual sense because a software component could be buggy and produce incorrect results. Additionally, attestation provides no information about the current state of the running system, such as a software component that has been compromised by a buffer overflow attack, infected by a virus, replaced by a newer version of code, etc.

[**0063**] Message flow **300** of **FIG. 3** illustrates an exemplary message flow diagram according to the present invention that provides signalling of an altered software or hardware component after attestation has taken place between a trustor and a trustee. The altered component(s) is(are) identified by the trustee and the appropriate signalling is then generated by the trustee to the trustor.

[**0064**] Message flows **302** and **304** represents the initial attestation between trustor and trustee that allows the trustor to establish a trust relationship with the trustee as discussed above. The trustee's platform change may be monitored, compared, and reported according to the pre-defined trust conditions specified by the trustor for the intended purpose. These trust conditions are confirmed by the trustee during the trust attestation. Message flows **306** and **308** represents further attestation between trustor and trustee that establishes trust conditions for a special purpose. For example,

the trustor wishes to bootstrap the trustee as to the particular software applications that may be executed on the computing platform of the trustee. Once the trustee has agreed to the bootstrap, confirmation **308** is generated by the trustee to guarantee to the trustor that the bootstrap will be adhered to and transactions **310** between the trustor and trustee may then proceed.

[**0065**] After some amount of time has transpired, condition changes **312** within the trustee's computing platform pose a threat to the trust gained by the trustor through confirmation **308**. For example, a software update may have occurred on one or more of the software applications that was included in the bootstrap requested by the trustor causing the integrity metrics to change. Alternately, a hardware change or a hardware status change may have occurred within the trustee's computing platform to cause the integrity metrics to change. In any event, the trustee gathers all information relating to the integrity change taking place within its computing platform and signals the change to trustor via message **314**. Message **314** may be delivered to the trustor via any pre-negotiated mechanism that is compatible to both trustee and trustor.

[**0066**] **FIG. 4** illustrates exemplary General Packet Radio Service (GPRS) network **400** in which the principles of the present invention may be practiced. GPRS network **400** is used, for example, to not only conduct messaging depicted in messages **302-310** of **FIG. 3** via path **430**, but also to propagate the distrust signalling message **314** via path **428** using the Multimedia Messaging Service (MMS). MMS is based on a store and forward model, whereby the distrust signal is forwarded to the trustor via, for example, a GPRS network as illustrated in **FIG. 4**. GPRS is a packet-switched service for Global System for Mobile Communications (GSM) that mirrors the Internet model and enables seamless transition towards 3G (third generation) networks. GPRS thus provides actual packet radio access for mobile GSM and time-division multiple access (TDMA) users, and is ideal for Wireless Application Protocol (WAP) services. While the exemplary embodiments of **FIG. 4** are generally described in connection with GPRS/GSM, it should be recognized that the specific references to GSM and GPRS are provided to facilitate an understanding of the invention. As will be readily apparent to those skilled in the art from the description provided herein, the invention is equally applicable to other technologies, including other circuit-switched and packet-switched technologies, 3G technologies, and beyond.

[**0067**] Referring to **FIG. 4**, mobile terminals **402** and **416** communicate with Base Transceiver Station (BTS) **404** and **408**, respectively, via an air interface. BTS **404** and **408** are components of the wireless network access infrastructure that terminates the air interface over which subscriber traffic is communicated to and from mobile terminals **402** and **416**. Base Station Controller (BSC) **405** and **409** are switching modules that provide, among other things, handoff functions, and power level control in each BTS **404** and **408**, respectively. BSC **405** and **409** controls the interface between a Mobile Switching Center (MSC) **406** and BTS **404** and **408**, and thus controls one or more BTSs in the call set-up functions, signaling, and in the use of radio channels. BSC **405** and **409** also controls the respective interfaces between Serving GPRS Support Node (SGSN) **410** and BTS **404** and SGSN **414** and BTS **408**.

[**0068**] SGSN **410** serves a GPRS mobile terminal by sending or receiving packets via a Base Station Subsystem (BSS), and more particularly via BSC **405** and **409** in the context of GSM systems. SGSN **410** and **414** are responsible for the delivery of data packets to and from mobile terminals **402** and **416**, respectively, within the service area, and performs packet routing and transfer, mobility management, logical link management, authentication, charging functions, etc. In the exemplary GPRS embodiment shown in **FIG. 4**, the location register of SGSN **410** stores location information such as the current cell and Visiting Location Register (VLR) associated with mobile terminal **402**, as well as user profiles such as the International Mobile Subscriber Identity Number (IMSI) of all GPRS users registered with SGSN **410**. SGSN **414** performs similar functions relating to mobile terminal **416**. SGSN **410** and **414** are ultimately coupled to MMSC **420** in connection with the presently described embodiment. While GSM forms the underlying technology, SGSN **410** and **414** described above are network elements introduced through GPRS technology. Another network element introduced in the GPRS context is the Gateway GPRS Support Node (GGSN) **422**, which acts as a gateway between the GPRS network **418** and WAP gateway **424**.

[**0069**] Multimedia Messaging Service Center (MMSC) **420** provides messaging capabilities for the delivery of multimedia messages composed of text, photographs, video, and other media types. The messaging capabilities include mobile originated messages sent to other mobile terminals or applications and application originated messages sent to mobile terminals or other applications. MMSC **420** is responsible for storing incoming and outgoing MMS messages, as well as the transfer of messages between different messaging systems.

[**0070**] With the aforementioned network system described as a representative network environment, a trusted messaging scenario is now described in which a WAP Push Framework is utilized to deliver the distrust signalling according to the principles of the present invention. Dashed line **430** represents, for example, the messaging path used for transfer of messages **302-310** of **FIG. 3**. Dashed line **428** represents the source multimedia message from mobile terminal **402**, which is ultimately posted to MMSC **420**. Mobile terminal **402** is acting as a mobile server to trustor **442**, whereby trusted content is transferred via path **430** until such time that a configuration change within mobile terminal **402** causes distrust signalling to report the configuration change. The distrust signalling is received by trustor **442** via MMSC **420** from mobile terminal **402**, in which case trustor **442** must decide which action to take next.

[**0071**] The WAP protocol suite is used as the data transport mechanism because WAP provides data transport services that are optimized for mobile networks. WAP also provides uniform transport services regardless of the underlying network. In particular, the Wireless Session Protocol (WSP) layer supplies the basis of the transport mechanism. Distrust signalling via, for example, an MMS message is sent by mobile terminal **402** for delivery to trustor **442** via an M-Send.req Protocol Data Unit (PDU) which contains the Multipurpose Internet Mail Extensions (MIME) encapsulated MMS message content. Either the address of trustor **442** or a token representing the address of trustor **442** is provided within the PDU, along with the content type of the

PDU. Dashed line **428** indicates the M-Send.req PDU message flow from mobile terminal **402** to MMSC **420**. While WSP provides the wireless transport from mobile terminal **402** to WAP gateway **424**, HTTP is used to complete the post request message progression to MMSC **420**. WAP gateway **424** provides the necessary functionality required to support HTTP encapsulation as required to support multimedia messaging to MMSC **420**. It should be noted that although MMS is illustrated in **FIG. 4** as the distrust signalling transport, alternate methods of transport may be used, such as the Short Messaging Service (SMS). In other embodiments, proximity communications using Bluetooth or Infrared (IR), for example, may be used to communicate the distrust signalling. Wired communications may also be used for distrust signalling transport such as specified by the RS232 or RS432 standards, and also may include differential data transmission formats such as specified by the RS422 or RS485 standards. Other wired implementations for higher bandwidth considerations may use the Universal Serial Bus (USB), or FireWire, specifications for example.

[**0072**] **FIG. 5** illustrates exemplary distrust signal reporting system structure **500** that may be employed by a trustee to detect and signal a change to the trustee's computing platform's configuration or state change. A trustee may be represented by any number of computing terminals to include mobile terminals, Personal Digital Assistants (PDA), laptop computers, PCs, workstations, etc. Trust conditions **502** represents the required bootstrap as communicated by the trustor (not shown) that prescribes the set of hardware and software functionalities or status that may be employed by the trustee, such that the trustor is able to maintain a trust relationship with the trustee.

[**0073**] Computing platform CAN **504** receives the trust conditions **502** and checks them against sign-in information monitor **508** of the trustee. Contributing to sign-in information monitor **508** are software (SW) updates **516**, hardware (HW) updates **514**, HW status **512**, and other **510**, which are combined by sign-in information monitor **508** to calculate a configuration image that represents the current execution state of the trustee. HW status **512** may represent a change in the operational state of the trustee's hardware indicating, for example, that a Universal Serial Bus (USB) is non-functional, or that a memory check has failed. SW updates **516** may occur when upgrading to a more recent version of an application executing on the trustee. HW update **514** may occur, for example, when expanding the Random Access Memory (RAM) allocation for the trustee. Other **510** may alter the image of the trustee when, for example, a new user has logged into the trustee.

[**0074**] In one embodiment according to the present invention, integrity metrics may be measured at regular intervals, whereby sign-in information monitor **508** collects any configuration data available from inputs **510-516** and calculates the image relating to the current configuration of the trustee. In another embodiment according to the present invention, a detection mechanism may be employed to detect any of configuration changes **510-516** to cause a recalculation of integrity metrics. Computing platform CAN **504** checks trust conditions **502** received from the corresponding trustor against sign-in information monitor **508** to detect any differences. All differences are then formulated into distrust signal **506** and then communicated to the trustor. The trustor then must decide the next step to take in response to the distrust signal.

[**0075**] The invention is a modular invention, whereby processing functions within either a TPM enabled mobile terminal or server may be utilized to implement the present invention. The mobile devices may be any type of wireless device, such as wireless/cellular telephones, personal digital assistants (PDAs), or other wireless handsets, as well as portable computing devices capable of wireless communication. These landline and mobile devices utilize computing circuitry and software to control and manage the conventional device activity as well as the functionality provided by the present invention. Hardware, firmware, software or a combination thereof may be used to perform the various trusted messaging functions described herein. An example of a representative mobile terminal computing system capable of carrying out operations in accordance with the invention is illustrated in **FIG. 6**. Those skilled in the art will appreciate that the exemplary mobile computing environment **600** is merely representative of general functions that may be associated with such mobile devices, and also that landline computing systems similarly include computing circuitry to perform such operations.

[**0076**] The exemplary mobile computing arrangement **600** suitable for facilitating trusted communications in accordance with the present invention may be associated with a number of different types of wireless devices. The representative mobile computing arrangement **600** includes a processing/control unit **602**, such as a microprocessor, reduced instruction set computer (RISC), or other central processing module. The processing unit **602** need not be a single device, and may include one or more processors. For example, the processing unit may include a master processor and associated slave processors coupled to communicate with the master processor. The processing unit also includes a TPM chip **630** used to establish mobile computing arrangement **600** as a trusted computing platform.

[**0077**] The processing unit **602** controls the basic functions of the mobile terminal, and also those functions associated with the present invention as dictated by distrust signal module **626** and TPM engine **628** available in the program storage/memory **604**. TPM engine **628** facilitates communications between TPM **630** and distrust signal module **626** in order to fulfill the functions in accordance with the present invention. Thus, the processing unit **602** is capable of calculating its own configuration image and generating a distrust signal if the configuration image does not match previously agreed upon trust conditions. The functionality described in relation to distrust signal reporting system structure **500** of **FIG. 5** may, however, be distributed throughout mobile computing arrangement **600**. That is to say that distrust signal module **626** and TPM engine **628** may be components that reside within TPM **630**, within processor **602**, or distributed between TPM **630** and processor **602**. Alternately, the functionality represented by TPM **630**, distrust signal module **626**, and TPM engine **628** may all be incorporated within processor **602** to provide a completely integrated processor in accordance with the present invention.

[**0078**] The program storage/memory **604** may also include an operating system and program modules for

carrying out functions and applications on the mobile terminal. For example, the program storage may include one or more of read-only memory (ROM), flash ROM, programmable and/or erasable ROM, random access memory (RAM), subscriber interface module (SIM), wireless interface module (WIM), smart card, or other removable memory device, etc.

[**0079**] In one embodiment of the invention, the program modules associated with the storage/memory **604** are stored in non-volatile electrically-erasable, programmable ROM (EEPROM), flash ROM, etc. so that the information is not lost upon power down of the mobile terminal. The relevant software for carrying out conventional mobile terminal operations and operations in accordance with the present invention may also be transmitted to the mobile computing arrangement **600** via data signals, such as being downloaded electronically via one or more networks, such as the Internet and an intermediate wireless network(s).

[**0080**] The processor **602** is also coupled to user-interface **606** elements associated with the mobile terminal. The user-interface **606** of the mobile terminal may include, for example, a display **608** such as a liquid crystal display, a keypad **610**, speaker **612**, and microphone **614**. These and other user-interface components are coupled to the processor **602** as is known in the art. Other user-interface mechanisms may be employed, such as voice commands, switches, touch pad/screen, graphical user interface using a pointing device, trackball, joystick, or any other user interface mechanism.

[**0081**] The mobile computing arrangement **600** also includes conventional circuitry for performing wireless transmissions. A digital signal processor (DSP) **616** may be employed to perform a variety of functions, including analog-to-digital (A/D) conversion, digital-to-analog (D/A) conversion, speech coding/decoding, encryption/decryption, error detection and correction, bit stream translation, filtering, etc. The transceiver **618**, generally coupled to an antenna **620**, transmits the outgoing radio signals **622** and receives the incoming radio signals **624** associated with the wireless device.

[**0082**] The mobile computing arrangement **600** of **FIG. 6** is provided as a representative example of a computing environment in which the principles of the present invention may be applied. From the description provided herein, those skilled in the art will appreciate that the present invention is equally applicable in a variety of other currently known and future mobile and landline computing environments. For example, desktop computing devices similarly include a processor, memory, a user interface, and data communication circuitry. Thus, the present invention is applicable in any known computing structure where data may be communicated via a network.

[**0083**] Using the description provided herein, the invention may be implemented as a machine, process, or article of manufacture by using standard programming and/or engineering techniques to produce programming software, firmware, hardware or any combination thereof. Any resulting program(s), having computer-readable program code, may be embodied on one or more computer-usable media, such as disks, optical disks, removable memory devices, semiconductor memories such as RAM, ROM, PROMS, etc. Articles of manufacture encompassing code to carry out functions associated with the present invention are intended to encompass a computer program that exists permanently or temporarily on any computer-usable medium or in any transmitting medium which transmits such a program. Transmitting mediums include, but are not limited to, transmissions via wireless/radio wave communication networks, the Internet, intranets, telephone/modem-based network communication, hard-wired/cabled communication network, satellite communication, and other stationary or mobile network systems/communication links. From the description provided herein, those skilled in the art will be readily able to combine software created as described with appropriate general purpose or special purpose computer hardware to create a trusted computing system and method in accordance with the present invention.

[**0084**] The trusted servers or other systems for providing trusted computing functions in connection with the present invention may be any type of computing device capable of processing and communicating digital information. The trusted servers utilize computing systems to control and manage the computing activity. An example of a representative computing system capable of carrying out operations in accordance with the invention is illustrated in **FIG. 7**. Hardware, firmware, software or a combination thereof may be used to perform the various trusted functions and operations described herein. The computing structure **700** of **FIG. 7** is an example computing structure that can be used in connection with such a trusted system.

[**0085**] The example computing arrangement **700** suitable for performing the trusted computing activity in accordance with the present invention includes trusted server **701**, which includes a central processor (CPU) **702** coupled to random access memory (RAM) **704**, read-only memory (ROM) **706**, and TPM chip **730**. It should be noted that functions in accordance with the present invention may be imbedded within TPM chip **730**, processor **702**, or alternately separated from both of them and provided elsewhere. The ROM **706** may also be other types of storage media to store programs, such as programmable ROM (PROM), erasable PROM (EPROM), etc. The processor **702** may communicate with other internal and external components through input/output (I/O) circuitry **708** and bussing **710**, to provide control signals and the like. External data storage devices may be coupled to I/O circuitry **708** to facilitate trusted computing functions according to the present invention. Alternatively, such databases may be locally stored in the storage/memory of the server **701**, or otherwise accessible via a local network or networks having a more extensive reach such as the Internet **728**. The processor **702** carries out a variety of functions as is known in the art, as dictated by software and/or firmware instructions.

[**0086**] Trusted server **701** may also include one or more data storage devices, including hard and floppy disk drives **712**, CD-ROM drives **714**, and other hardware capable of reading and/or storing information such as DVD, etc. In one embodiment, software for carrying out the trusted computing operations in accordance with the present invention may be stored and distributed on a CD-ROM **716**, diskette **718** or other form of media capable of portably storing information. These storage media may be inserted into, and read by, devices such as the CD-ROM drive **714**, the disk drive **712**, etc. The software may also be transmitted to trusted server **701** via data signals, such as being downloaded electronically via a network, such as the Internet. Trusted server **701**

is coupled to a display **720**, which may be any type of known display or presentation screen, such as LCD displays, plasma display, cathode ray tubes (CRT), etc. A user input interface **722** is provided, including one or more user interface mechanisms such as a mouse, keyboard, microphone, touch pad, touch screen, voice-recognition system, etc.

[**0087**] The trusted server **701** may be coupled to other computing devices, such as the landline and/or wireless terminals via a network. The server may be part of a larger network configuration as in a global area network (GAN) such as the Internet **728**, which allows ultimate connection to the various landline and/or mobile client/watcher devices.

[**0088**] A method according to the present invention that may be implemented by any trusted platform, e.g., mobile terminal or server, acting as a trustee in a trusted exchange with a trustor is exemplified by procedure **800** of **FIG. 8**. Procedure **800** provides a solution to establish and maintain conditional trust by stating distrust signals from a trustee's computing platform. In step **802**, attestation of trust is established between a trustee and a trustor. The trustee operates TPS **100** as illustrated in **FIG. 1**, but in addition, also operates a distrust signal reporting system structure as depicted in **FIG. 5**.

[**0089**] In step **804**, the trustor generates a set of integrity metrics that define the execution state of the trustee that is required in order for the trustor to maintain its trust in the trustee during the intended purpose. The trustee monitors sign-in information monitor **508** for any changes caused by influences **510-516** as in step **806**. If an influence has occurred, it is detected in step **808** and sign-in information monitor **508** generates new integrity metrics in step **810** to include the effects of the influence. It should be noted, that influence monitor step **806** may be conducted according to the trust conditions. In other words, only those influences that pertain to the trust conditions are monitored, where the trust conditions may be used as a filter by influence monitor step **806** in order to reduce costs. The new integrity metrics are then delivered to computing platform CAN **504** whereby computing platform CAN **504** measures the difference between trust conditions **502** and the new integrity metrics. Any differences between trust conditions **502** and the newly generated sign-in information monitor **508** are detected in step **812** and reported by computing platform CAN **504** in the form of distrust signal **506** as in step **814**.

[**0090**] An improvement to the prior art trusted platform subsystem of **FIG. 1** is exemplified by improved TPS **900** of **FIG. 9** in accordance with the present invention. The operation of Distrust Signal Reporting (DSR) module **910** has been generally discussed above in relation to **FIG. 5**. Trust conditions **502** are received by DSR **910** via path **922** from TPA **908**. Hardware and software monitor signals are received from computing platform **914** via path **916**, whereby sign-in information monitor **508** receives them and computes the image that reflects the configuration of computing platform **914**. Computing platform CAN **504** then checks the computed configuration against trust conditions **502** and stores the result in ROT **906** via path **920**. If the check does not yield a match, the distrust signal **506** is generated and sent to TPA **908** via path **922**. TPA **908** then transmits the distrust signal to the trustor so that the appropriate action may be taken by the trustor.

[**0091**] Another application where the advantages of the present invention are beneficial is associated with software applications that conform to the Mobile Information Device Profile (MIDP), e.g., MIDlets. MIDP is a set of APIs that define how software applications interface with, for example, mobile terminals and two-way pagers. J2ME is a highly optimized Java runtime environment, where J2ME technology specifically addresses the vast consumer space, which covers the range of extremely tiny commodities such as smart cards or a pager all the way up to the set-top box, an appliance almost as powerful as a computer.

[**0092**] The J2ME architecture defines configurations, profiles, and optional packages as elements for building complete Java runtime environments that meet the requirements for a broad range of devices and target markets. Each combination is optimized for the memory, processing power, and Input/Output (I/O) capabilities of a related category of devices. The result is common J2ME platform **1000** as illustrated in **FIG. 10** that fully leverages each type of Mobile Information Device (MID) **1008** to deliver a richer user experience. MID **1008** may comprise any one of a mobile phone **1012**, PDA **1014**, laptop computer **1018**, or other device **1016**, such as a two-way pager, for example.

[**0093**] Connected Limited Device Configuration (CLDC) **1006** is a J2ME configuration that is comprised of a virtual machine and a minimal set of class libraries. CLDC **1006** provides the base functionality for a particular range of devices that share similar characteristics, such as network connectivity and memory footprint. CLDC **1006** is designed for MIDs **1008**, that operate with intermittent network connections, slow processors, or limited memory.

[**0094**] MIDP **1004** offers the core application functionality required for mobile applications, including the user interface, network connectivity, local data storage, and application management. Combined with CLDC **1006**, MIDP **1004** provides a complete Java runtime environment that leverages the capabilities of handheld devices and minimizes both memory and power consumption. J2ME platform **1000** is further extended by combining optional packages **1002** with CLDC **1006** to provide standard APIs for using both existing and emerging technologies, such as Bluetooth, Web Services, wireless messaging, multimedia, and database connectivity.

[**0095**] Kilo Virtual Machine (KVM) **1010** is a complete Java virtual machine that maintains all the aspects of the Java programming language, but runs in a resource constrained device having only a few hundred kilobytes (kB) of memory budget. Several usage models are available for KVM **1010**. For example, KVM **1010** may be used on an existing native software stack to give the device the ability to download and run dynamic, interactive, and secure Java content on the device. Alternately, KVM **1010** is used at a lower level to implement the lower level system software and applications of the device in the Java programming language.

[**0096**] MIDP applications, i.e., MIDlet suites, that execute on MID **1008** may be deployed Over the Air (OTA), or conversely, via wired networks to MIDs distributed throughout the network. Mechanisms are provided within the MIDs that allow users to discover MIDlet suites that can be downloaded into the MID. In some cases, discovery of the MIDlet suite is conducted via the MID's resident browser

and in other cases, a resident application written specifically to identify MIDlet suites is used.

[0097] MIDlet suite discovery and download scenario **1100** is presented in **FIG. 11** that depicts MIDlet suite provider **1102** having MIDlet suite **1124** available for download to MID **1106** via network **1104**. MID **1106** is a trusted platform design in accordance with the present invention, in which Root Trust (RT) module **1108** of MID **1106** attests Operating System Trust (OST) **1110** to establish the first trust chain link. OST **1110** attests the KVM Trust (KVMT) **1112**, CLDC Trust (CLDCT) **1114** and java profile to set up the next trust chain link and complete the trusted Java running platform at MID **1106**.

[0098] Transfer of MIDlet suite **1124** and its associated Application Descriptor (AD) file to MID **1106** is conducted via path **1120** using, for example, HyperText Transfer Protocol (HTTP) or a session protocol that implements the HTTP functionality including the header and entity fields. Security challenges may be issued by MIDlet suite provider **1102** using, for example, 401 UNAUTHORIZED or 407 PROXY AUTHENTICATION REQUIRED messages, in response to a MIDlet suite request issued by MID **1106** via path **1122**. The challenge response, including username and password credentials, may be transmitted by MID **1106** via path **1122** by re-sending the HTTP request with the credentials supplied in the appropriate header fields. Paths **1120** and **1122** may be implemented using wire, e.g., USB, FireWire, or wireless, e.g., WAP, Bluetooth, IR, communication mediums.

[0099] In order to install or update the MIDlet suite onto MID **1106**, a Java Archive (JAR) file should be created and transmitted by MIDlet suite provider **1102** to MID **1106**. The JAR file contains the class files, a manifest file, and any resource files used by the MIDlet suite. In addition according to the present invention, Trust Condition (TC) file **1126** may be included with the JAR file, so that MID **1106** may extract, verify, and register Midlet suite **1124** with the trusted Java platform trust chain **1108-1114** of MID **1106**. The registrations of trust conditions may be understood by referring back to **FIG. 5**, where trust condition **502**, e.g., TC file **1126**, is registered with computing platform CAN **504**, residing within MID **1106**. The trust conditions are then checked against the current configuration of MID **1106** to ultimately complete the trust chain link to MIDlet Trust (MT) **1116** and MIDlet Provider Trust (MPT) **1118**, since any difference between the trusted conditions and the current configuration are reported to MIDlet provider **1102**. The TC file **1126** may alternately be included with the AD file, which is provided to the Application Management Software (AMS) executing within MID **1106** for AMS verification as to the MIDlet suite's configuration, such as the MIDlet suite's status, settings, changes, operations on it, etc.

[0100] TC file **1126** is preferably described by eXtensible Markup Language (XML), and may be protected by any security measures used for XML if the TC file is expressed in XML. The XML trust condition expressions and associated Document Type Definitions (DTD) are exemplified in the following XML code sequence:

```
<?xml version="1.0" encoding="UTF-8"?>
<trustConditions identity='MIDLET-1' idtype='SW-
Java-MIDlet'>
    <Restrict>
        <operation>
            <name>copy </name>
            <runner>owner </runner>
        </operation>
        <operation>
            <name> forward </name>
            <runner> owner </runner>
            <method> any </method>
        </operation>
    </Restrict>
    <RunEnvironment>
        <Hardware name="all">
            <Restrict>
                <operation>
                    <name> change </name>
                <operation>
            </Restrict>
        </Hardware>
        <Software name="rest">
            <Restrict>
                <operation>
                    <name> change </name>
                <operation>
            </Restrict>
        </software>
    </RunEnvironment>
</trustConditions>
<?xml version="1.0" encoding="UTF-8"?>
<!-- Trust Condition Definition -->
<!-- Change History -->
<!-- First draft Zheng Yan (07.05.2003) -->
<!-- Introduction -->
<!-- This DTD defines trust condition definition for auto
warn distrust event -->
<!ELEMENT trustConditions (Restrict?, RunEnvironment?)>
    <!ATTLIST trustConditions identity CDATA #REQUIRED
                              idtype CDATA #IMPLIED>
<!-- identity is a unique ID used for identifying a platform
component, e.g. HW or SW -->
<!-- ##################################################-->
<!-- # ELEMENT Restrict                                #-->
<!-- ##################################################-->
    <!ELEMENT Restrict (operation*)>
        <!ELEMENT operation (name, time?, runner?, method?)>
            <!ELEMENT name (#PCDATA|copy|forward|change)>
            <!ELEMENT time (#PCDATA)>
            <!ELEMENT runner (#CDATA)>
            <!ELEMENT method (#PCDATA)>
<!-- ##################################################-->
<!-- # ELEMENT RunEnvironment                          #-->
<!-- ##################################################-->
    <!ELEMENT RunEnvironment (Hardware*, Software*)>
        <!ELEMENT Hardware (Restrict)>
            <!ATTLIST Hardware identity CDATA #IMPLIED
                               name CDATA # REQUIRED
                               idtype CDATA #IMPLIED>
        <!ELEMENT software (Restrict)>
            <!ATTLIST Software identity CDATA #IMPLIED
                               name CDATA #REQUIRED
                               idtype CDATA #IMPLIED>
```

[0101] The trust conditions specified within TC file **1126** uses identities, which are unique identifications to for identifying a platform component, e.g., hardware or software component. The DTD is included to define a trust condition, such that when the trust condition is not met, an automatic warn distrust event occurs. Element "Restrict" contains restrictions on the operation of the underlying component.

Element "RunEnvironment" contains restrictions on the running environment of the underlying identified component.

[0102] MIDlet installation/upgrade method **1200** is exemplified in the flowchart of **FIG. 12** provides an exemplary sequence of steps employed by the present invention to monitor the trust chain established between the MIDs, the MIDlet suites, and their associated suppliers as illustrated in **FIG. 11**. In step **1202**, MID **1106** checks its current trusted configuration state and determines in step **1204** whether a MIDlet installation or upgrade has commenced. If so, then TC **1126** is extracted from MIDlet suite **1124** in step **1206** and registered with computing platform CAN, e.g., **504**, residing within MID **1106** as in step **1208**. The computing platform CAN monitors the HW and SW operation at the underlying MID platform in step **1210** and checks it against the trust conditions extracted in step **1206**. If a change is detected **1212**, MIDlet provider **1102** is notified **1214** via path **1122** according to a provider preferred method. A change may be detected, for example, if after the installation or upgrade of the MIDlet suite, the user of MID **1106** modifies the MIDlet suite for his own purposes, such that the restrictions imposed upon the MIDlet suite by elements "Restrict" in TC file **1126**, for example, are violated.

[0103] It can be seen, therefore, that the trust chain between MID **1106**, e.g., **1108-1116**, and MIDlet provider **1102**, e.g., **1118**, can be extended through use of the present invention. If, for example, the user of MID **1106** modifies the newly installed MIDlet suite, then through operation of the computing platform CAN **504**, the change is detected and signalled back to the MIDlet provider via the auto warn method exemplified in **FIG. 12**. In this way, even if the user modifies the MIDlet suite using the provider's correct data for subsequent attestation, the change may be detected and reported back to the MIDlet supplier so that the MIDlet supplier may take the appropriate action.

[0104] The above example may be extended to any content provider and its associated content. That is to say that content providers offering any form of software/digital data such as images, video streams, executables, source code, ring tones, games, etc., that may be provided to any other consumption device may establish conditional trust between the consumption device and the provided content. A trust condition file may be generated by the content provider and provided to a computing platform CAN within the consumption device, such that distrust signals may be generated by the consumption device under distrust conditions. In other words, whenever the consumption device detects, for example, any one of a software status change, a hardware status change, a software setting change, a hardware setting change, a software change, a hardware change, a hardware operation change, an Input/Output (I/O) change, and/or a software operation change with respect to the trusted condition file, the consumption device provides a distrust signal to the content provider, so that the content provider may take the appropriate action.

[0105] The foregoing description of the various embodiments of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. Thus, it is intended that the scope of the invention be limited not with this detailed description, but rather determined from the claims appended hereto.

What is claimed is:

1. A method for establishing and maintaining conditional trust between a trustee and a trustor, comprising:

generating metrics by a trustor that represents a trusted condition;

comparing the generated metrics to current metrics of a trustee; and

issuing a distrust signal by the trustee in response to a mismatch between the generated metrics of the trustor and the current metrics of the trustee.

2. The method according to claim 1, wherein comparing the generated metrics to the current metrics occurs in response to an influence.

3. The method according to claim 2, wherein the influence includes at least one of a software or hardware component change within the trustee.

4. The method according to claim 2, wherein the influence includes a hardware status change within the trustee.

5. The method according to claim 1, wherein comparing the generated metrics to the current metrics occurs at time intervals.

6. The method according to claim 1, wherein issuing the distrust signal uses a wireless mechanism for distrust signal delivery.

7. The method according to claim 1, wherein issuing the distrust signal uses a wired mechanism for distrust signal delivery.

8. The method according to claim 6, wherein the wireless mechanism includes one of a Multimedia Messaging Service (MMS) or a Short Message Service (SMS) message.

9. The method according to claim 1, further comprising initially establishing a trust attestation.

10. A trusted computing system, comprising:

a trustor terminal coupled to provide a trust condition to define a configuration state; and

a trustee terminal coupled to receive the trust condition and coupled to provide attestation of the configuration state, wherein the trustee terminal provides a distrust signal when the configuration state does not match the trusted condition.

11. The trusted computing system according to claim 10, wherein the trustee terminal comprises:

a computing platform CAN coupled to receive the trust condition; and

a current integrity metric generator coupled to receive configuration inputs and coupled to provide the configuration state.

12. The trusted computing system according to claim 11, wherein the configuration inputs comprise one of a software configuration update, a hardware operation, a software operation, or a hardware status operation.

13. The trusted computing system according to claim 10, wherein the distrust signal is provided via a wireless connection.

14. The trusted computing system according to claim 10, wherein the distrust signal is provided via a wire connection.

15. The trusted computing system according to claim 13, wherein the wireless connection includes one of a Multimedia Messaging Service (MMS), a Short Message Service (SMS), Bluetooth, or Infrared (IR) connection.

16. The trusted computing system according to claim 10, wherein the trustee terminal includes one of a mobile terminal, laptop computer, personal computer, or server.

17. The trusted computing system according to claim 10, wherein the trustor terminal includes one of a mobile terminal, laptop computer, personal computer, or server.

18. A mobile terminal wirelessly coupled to a network which includes a network element capable of providing a trusted condition, the mobile terminal comprising:

a memory capable of storing at least a distrust signal module and a Trusted Platform Module (TPM) engine;

a processor coupled to the memory and configured by the TPM engine to enable a configuration attestation with the network element; and

a transceiver configured to facilitate a trusted condition exchange with the network element, wherein the processor is configured by the distrust signal module to provide a distrust signal when the configuration does not match the trusted condition.

19. The mobile terminal according to claim 18, wherein the distrust signal module comprises:

a computing platform CAN coupled to receive the trusted condition; and

a current integrity metric generator coupled to receive configuration inputs and coupled to provide the configuration.

20. The mobile terminal according to claim 19, wherein the configuration inputs comprise one of a software update, a hardware update, or a hardware status update to the mobile terminal.

21. A computer-readable medium having instructions stored thereon which are executable by a mobile terminal for maintaining a trusted system configuration by performing steps comprising:

receiving trusted conditions representing a required system configuration of the mobile terminal;

generating integrity metrics representative of a current system configuration of the mobile terminal; and

supplying a distrust signal representative of a difference between the required system configuration and the current system configuration.

22. A server within a network used to establish a trusted exchange with a mobile terminal, comprising:

means for providing a trusted condition to define a configuration state of the mobile terminal; and

means for receiving a distrust signal from the mobile terminal, wherein the distrust signal is indicative of a difference between a current configuration state of the mobile terminal and the trusted condition.

23. A computer-readable medium having instructions stored thereon which are executable by a server for facilitating trusted network computing by performing steps comprising:

providing a trusted condition to define a configuration state of a trustee terminal; and

receiving a distrust signal from the trustee terminal, wherein the distrust signal is indicative of a difference between a current configuration state of the trustee terminal and the trusted condition.

24. A distrust signal reporting system comprising:

a computing platform CAN configured to receive trust conditions from a trustor that defines a trusted configuration state; and

an information monitor coupled to the computing platform CAN and configured to monitor configuration and status signals from a trustee platform and to report a configuration state of the trustee platform to the computing platform CAN, wherein the computing platform CAN generates a distrust signal when the configuration state of the trustee platform does not match the trusted configuration state.

25. The distrust signal reporting system according to claim 24, wherein the distrust signal reporting system is integrated into a single processor.

26. The distrust signal reporting system according to claim 24, wherein the distrust signal reporting system is distributed between at least two processors.

27. A trusted platform system comprising:

a trustee computing platform configured to provide configuration and status signals relating to the trustee computing platform;

a Root of Trust (ROT) measurement module coupled to the trustee computing platform and configured to measure integrity metrics associated with the trustee computing platform in response to the configuration and status signals;

a ROT store module coupled to receive the integrity measurement metrics from the ROT measurement module;

a Trusted Platform Agent (TPA) coupled to receive trust conditions and challenges from a trustor and coupled to provide measurement data in response to the challenges; and

a distrust signal reporting module including:

a computing platform CAN coupled to the TPA to receive the trust conditions, wherein the trust conditions define a trusted configuration state; and

an information monitor coupled to the computing platform CAN and configured to monitor the configuration and status signals from the trustee computing platform and to report a configuration state of the trustee computing platform to the computing platform CAN, wherein the computing platform CAN checks the trust conditions against the configuration state of the trustee computing platform and generates a distrust signal to the TPA when the configuration state of the trustee platform does not match the trusted configuration state.

28. A method of providing conditional trust between a MIDlet provider and a Mobile Information Device (MID), comprising:

attaching trust conditions to a MIDlet suite contained within the MIDlet provider;

downloading the MIDlet suite and attached trust conditions to the MID;

checking the trust conditions against a configuration of the MID to determine a difference between the trust conditions and the configuration; and

reporting the difference to the MIDlet provider.

29. The method according to claim 28, wherein the trust conditions are defined using eXtensible Markup Language (XML).

30. The method according to claim 29, wherein the trust conditions define restrictions on the operation of the MIDlet suite.

31. The method according to claim 29, wherein the trust conditions define restrictions on the run environment of the MID for the MIDlet suite.

32. The method according to claim 28, wherein the MIDlet suite and trust conditions are downloaded using a wire connection.

33. The method according to claim 28, wherein the MIDlet suite and trust conditions are downloaded using a wireless connection.

34. The method according to claim 28, wherein the configuration of the MID includes one of a software status, a hardware status, a software setting, a hardware setting, a software change, a hardware change, a hardware operation or a software operation.

35. A method for establishing and maintaining conditional trust between a trustee and a trustor, comprising:

generating metrics by the trustor that represents a trusted condition;

sending the trusted condition to the trustee for a conditional trust reference;

generating metrics by the trustee according to the conditional trust reference at the trust attestation stage for an intended purpose;

registering the conditional trust reference at a trusted computing platform CAN within the trustee;

checking the trustee generated metrics against current metrics of the trustee according to the conditional trust reference; and

issuing a distrust signal by the trustee in response to a mismatch between the conditional trust reference and the current metrics of the trustee.

36. The method according to claim 35, further comprising registering the trustee generated metrics according to the conditional trust reference.

37. A method of providing conditional trust between a content provider and a device, comprising:

attaching trust conditions to content contained within the content provider;

downloading the content and attached trust conditions to the device;

checking the trust conditions against a configuration of the device to determine a difference between the trust conditions and the configuration; and

reporting the difference to the content provider.

38. The method according to claim 37, wherein the trust conditions are defined using eXtensible Markup Language (XML).

39. The method according to claim 38, wherein the trust conditions define restrictions on the operation of the content.

40. The method according to claim 38, wherein the trust conditions define restrictions on the run environment of the device for the content.

41. The method according to claim 37, wherein the content and trust conditions are downloaded using a wire connection.

42. The method according to claim 37, wherein the content and trust conditions are downloaded using a wireless connection.

43. The method according to claim 37, wherein the configuration of the device includes one of a software status, a hardware status, a software setting, a hardware setting, a software change, a hardware change, a hardware operation and a software operation.

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