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(54) **SYSTEM AND METHOD FOR MONITORING A UTILITY METER NETWORK**

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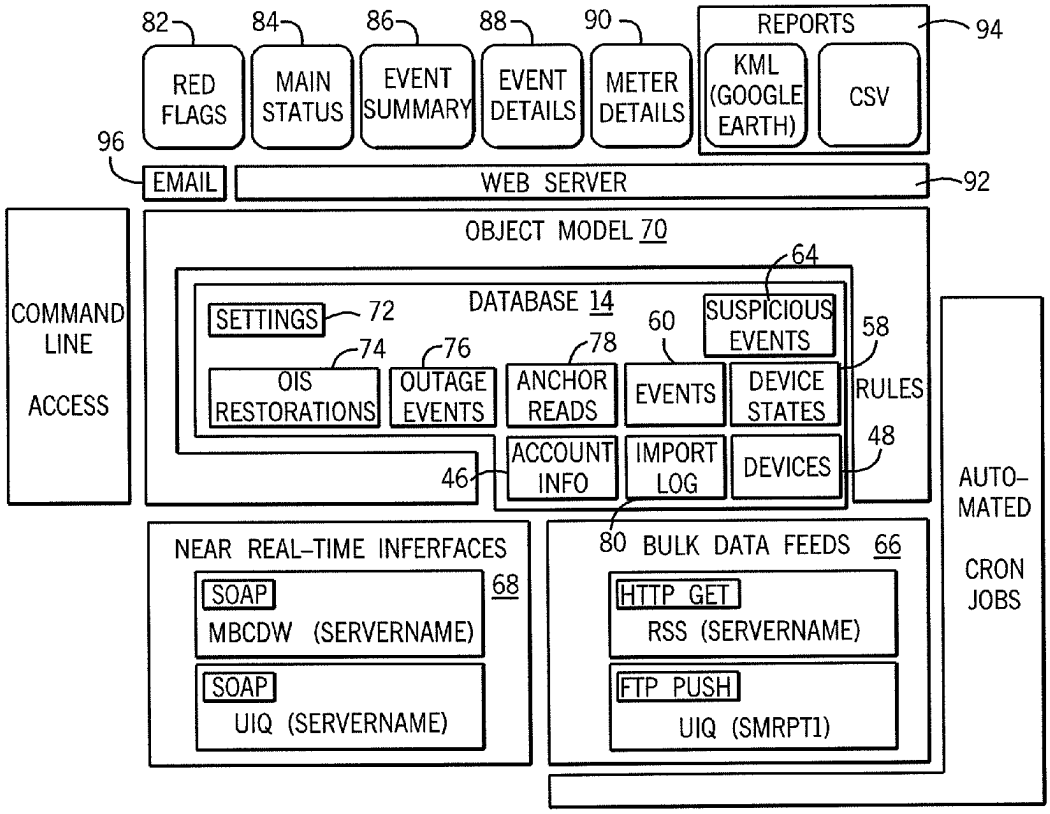
(57) **ABSTRACT**

Embodiments of the invention provide a method for monitoring a utility meter network. The method includes receiving data from a front-end utility application suite that communicates with one or more utility meters and storing the data in one or more databases. The method includes organizing the data according to the utility meter from which the data originated and processing the data using one or more rules to detect patterns and correlations indicative of one or more suspicious events. In some embodiments, the processed data is stored in a database and a report is produced if patterns and correlations indicative of one or more suspicious events are detected.



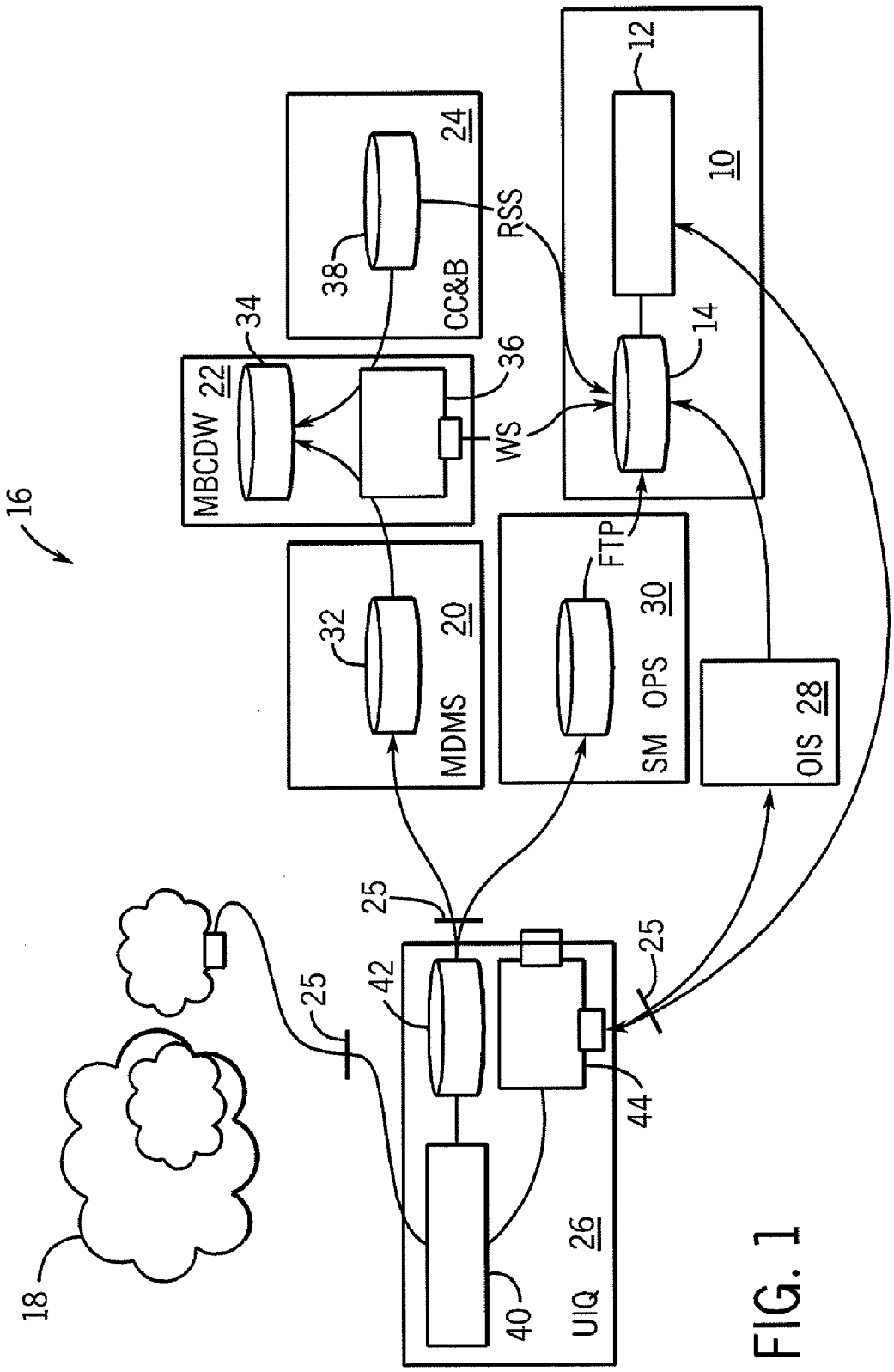
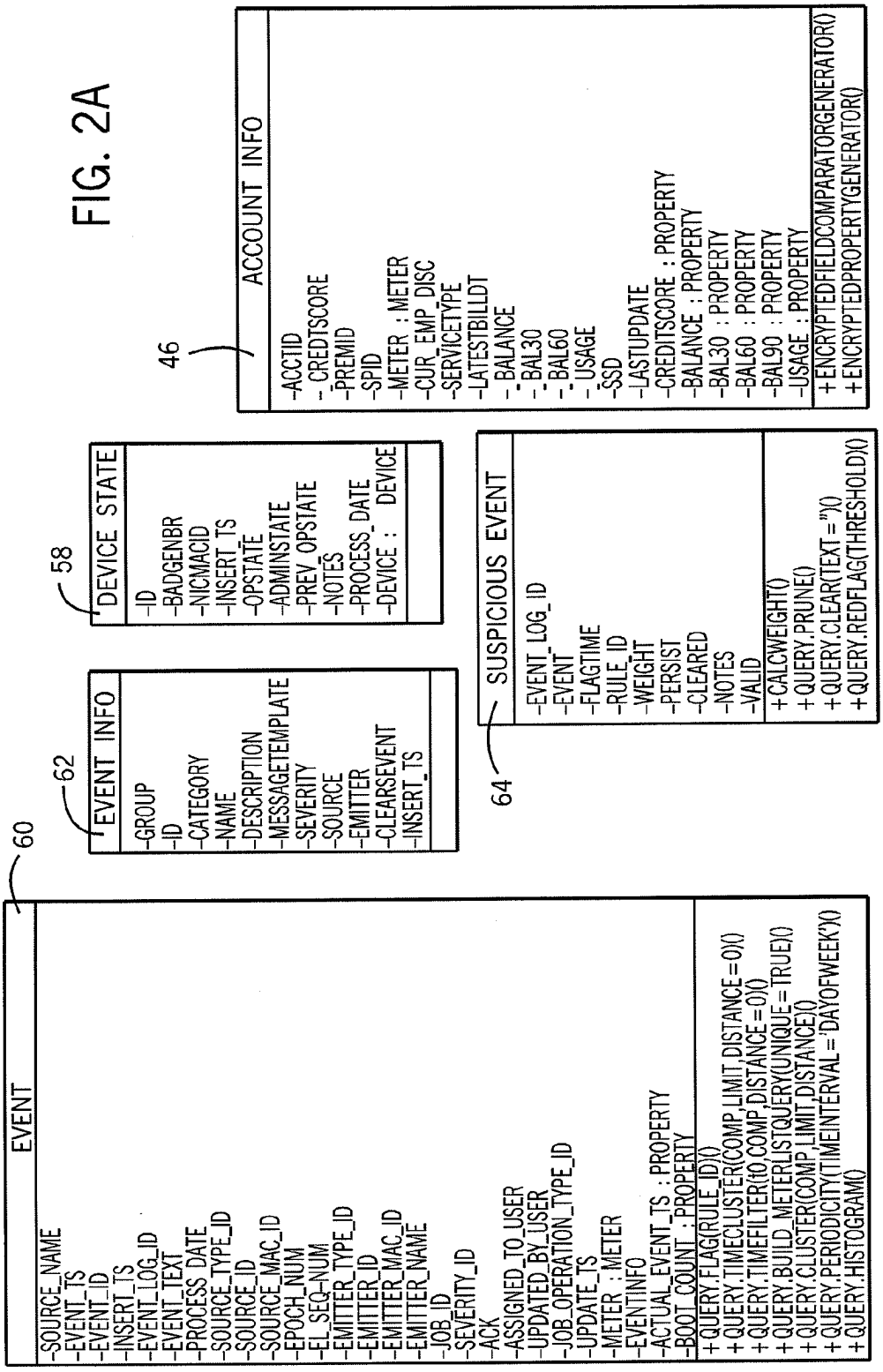

16
18
25
25
25
42
44
40
UIQ 26
MDMS 20
32
SM OPS 30
FTP
OIS 28
MBCDW 22
34
36
WS
CC&B 24
38
RSS
10
12
14

FIG. 1

FIG. 2A


EVENT
-SOURCE_NAME
-EVENT_TS
-EVENT_ID
-INSERT_TS
-EVENT_LOG_ID
-EVENT_TEXT
-PROCESS_DATE
-SOURCE_TYPE_ID
-SOURCE_ID
-SOURCE_MAC_ID
-EPOCH_NUM
-EL_SEQ-NUM
-EMITTER_TYPE_ID
-EMITTER_ID
-EMITTER_MAC_ID
-EMITTER_NAME
-JOB_ID
-SEVERITY_ID
-ACK
-ASSIGNED_TO_USER
-UPDATED_BY_USER
-JOB_OPERATION_TYPE_ID
-UPDATE_TS
-METER_: METER
-EVENTINFO
-ACTUAL_EVENT_TS : PROPERTY
-BOOT_COUNT : PROPERTY
+QUERY.FLAG(RULE_ID)()
+QUERY.TIMECLUSTER(COMP,LIMIT,DISTANCE=0)()
+QUERY.TIMEFILTER(tO,COMP,DISTANCE=0)()
+QUERY.BUILD_METERLISTQUERY(UNIQUE=TRUE)()
+QUERY.CLUSTER(COMP,LIMIT,DISTANCE)()
+QUERY.PERIODICITY(TIMEINTERVAL='DAYOFWEEK')()
+QUERY.HISTOGRAM()
60
EVENT_INFO
-GROUP
-ID
-CATEGORY
-NAME
-DESCRIPTION
-MESSAGETEMPLATE
-SEVERITY
-SOURCE
-EMITTER
-CLEAREVENT
-INSERT_TS
62
DEVICE_STATE
-ID
-BADGENBR
-NICMACID
-INSERT_TS
-OPSTATE
-ADMINSTATE
-PREV_OPSTATE
-NOTES
-PROCESS_DATE
-DEVICE : DEVICE
58
SUSPICIOUS_EVENT
-EVENT_LOG_ID
-EVENT
-FLAGTIME
-RULE_ID
-WEIGHT
-PERSIST
-CLEARED
-NOTES
-VALID
+CALCWEIGHT()
+QUERY.PRUNE()
+QUERY.CLEAR(TEXT = '')()
+QUERY.REDFLAG(THRESHOLD)()
64
ACCOUNT_INFO
-ACCTID
-_CREDTSCORE
-PREMID
-SPID
-METER : METER
-CUR_EMP_DISC
-SERVICETYPE
-LATESTBILLDT
-_BALANCE
-_BAL30
-_BAL60
-_USAGE
-SSD
-LASTUPDATE
-CREDITSCORE : PROPERTY
-BALANCE : PROPERTY
-BAL30 : PROPERTY
-BAL60 : PROPERTY
-BAL90 : PROPERTY
-USAGE : PROPERTY
+ENCRYPTEDFIELDCOMPARATORGENERATOR()
+ENCRYPTEDPROPERTYGENERATOR()
46

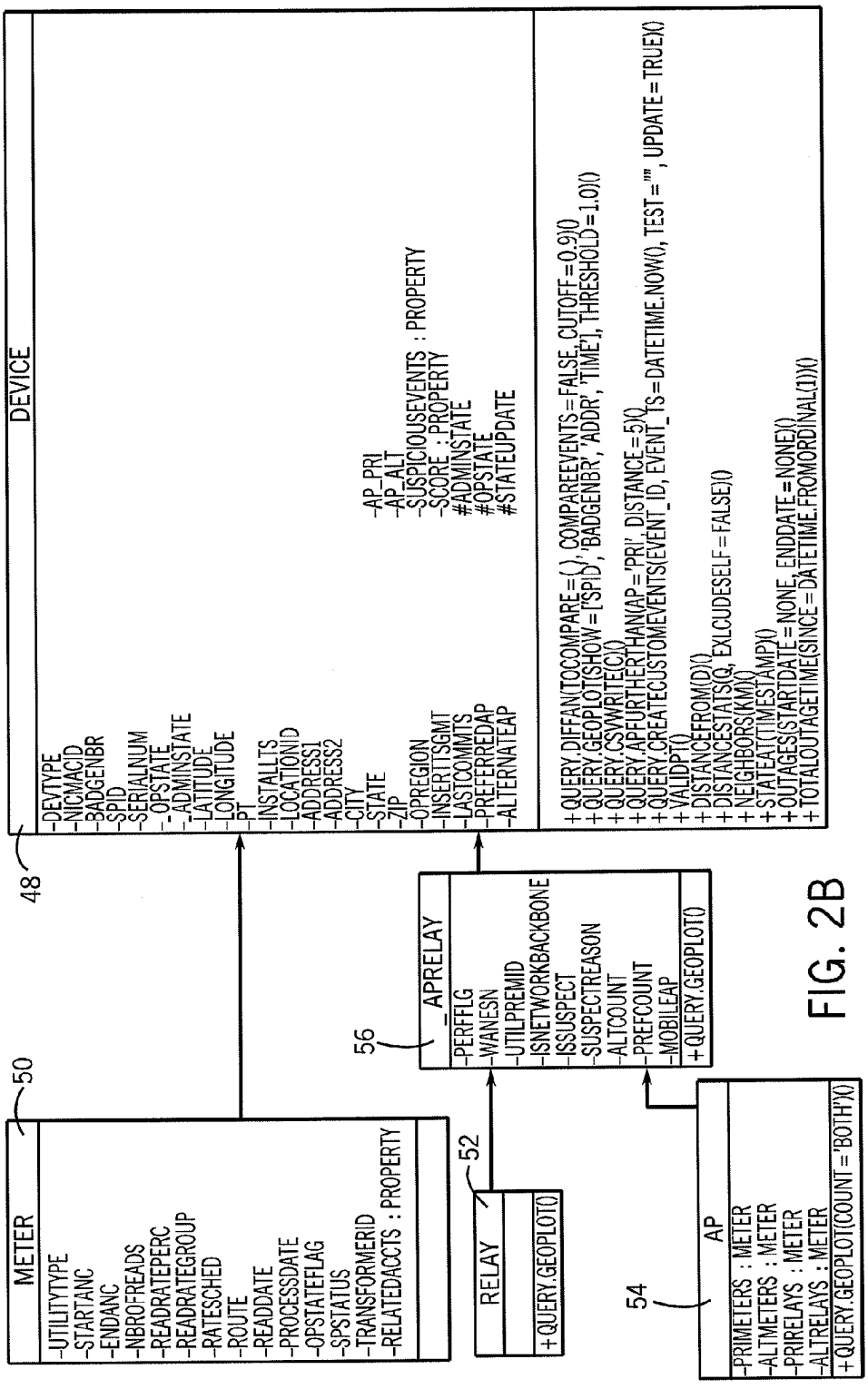

DEVICE
-DEVTYPE
-NICMACID
-BADGENBR
-SPID
-SERIALNUM
-OPSTATE
-ADMINSTATE
-LATITUDE
-LONGITUDE
-PT
-INSTALLTS
-LOCATIONID
-ADDRESS1
-ADDRESS2
-CITY
-STATE
-ZIP
-OPREGION
-INSERTTSGMT
-LASTCOMMTS
-PREFERREDAP
-ALTERNATEAP
-AP_PRI
-AP_ALT
-SUSPICIOUSEVENTS : PROPERTY
-SCORE : PROPERTY
#ADMINSTATE
#OPSTATE
#STATEUPDATE
+QUERY.DIFFAN(TOCOMPARE={}, COMPAREEVENTS=FALSE, CUTOFF=0.9)()
+QUERY.GEOPLOTISHOW=['SPID', 'BADGENBR', 'ADDR', 'TIME'], THRESHOLD=1.0)()
+QUERY.CSVWRITE(C)()
+QUERY.APFURTHERTHAN(AP='PRI', DISTANCE=5)()
+QUERY.CREATECUSTOMEVENTS(EVENT_ID, EVENT_TS=DATETIME.NOW(), TEST="", UPDATE=TRUE)()
+VALIDPT()
+DISTANCEFROM(D)()
+DISTANCESTATS(Q, EXLCUDESELF=FALSE)()
+NEIGHBORS(KM)()
+STATEATTIMESTAMP()()
+OUTAGES(STARTDATE=NONE, ENDDATE=NONE)()
+TOTALOUTAGETIMESINCE=DATETIME.FROMORDINAL(1)()
48
METER
-UTILITYTYPE
-STARTANC
-ENDANC
-NBROFREADS
-READRATEPERC
-READRATEGROUP
-RATESCHED
-ROUTE
-READDATE
-PROCESSDATE
-OPSTATEFLAG
-SPSTATUS
-TRANSFORMERID
-RELATEDACCTS : PROPERTY
50
RELAY
+QUERY.GEOPLOT()
52
_APRELAY
-PERFFLG
-WANESN
-UTILPREMID
-ISNETWORKBACKBONE
-ISSUSPECT
-SUSPECTREASON
-ALTCOUNT
-PREFCOUNT
-MOBILEAP
+QUERY.GEOPLOT()
56
AP
-PRIMETERS : METER
-ALTMETERS : METER
-PRIRELAYS : METER
-ALTRELAYS : METER
+QUERY.GEOPLOT(COUNT='BOTH')()
54

FIG. 2B

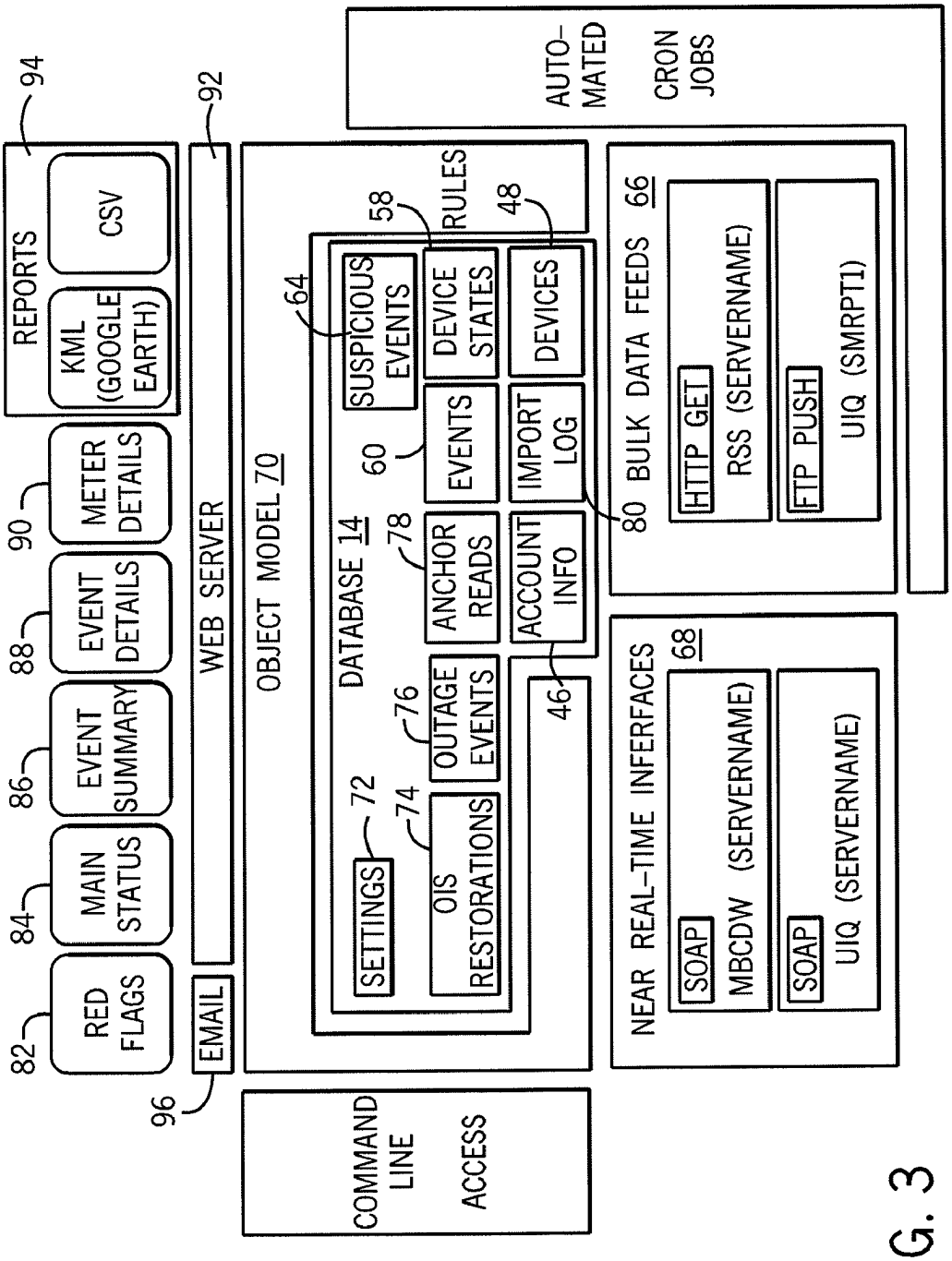

REPORTS
94
KML (GOOGLE EARTH)
CSV
METER DETAILS
90
EVENT DETAILS
88
EVENT SUMMARY
86
MAIN STATUS
84
RED FLAGS
82
EMAIL
96
WEB SERVER
92
OBJECT MODEL 70
DATABASE 14
SETTINGS
72
OIS RESTORATIONS
74
OUTAGE EVENTS
76
ANCHOR READS
78
ACCOUNT INFO
46
EVENTS
60
IMPORT LOG
SUSPICIOUS EVENTS
64
DEVICE STATES
58
DEVICES
RULES
48
COMMAND LINE ACCESS
NEAR REAL-TIME INFERFACES
68
SOAP
MBCDW (SERVERNAME)
SOAP
UIQ (SERVERNAME)
80 BULK DATA FEEDS 66
HTTP GET
RSS (SERVERNAME)
FTP PUSH
UIQ (SMRPT1)
AUTO-MATED
CRON JOBS

FIG. 3

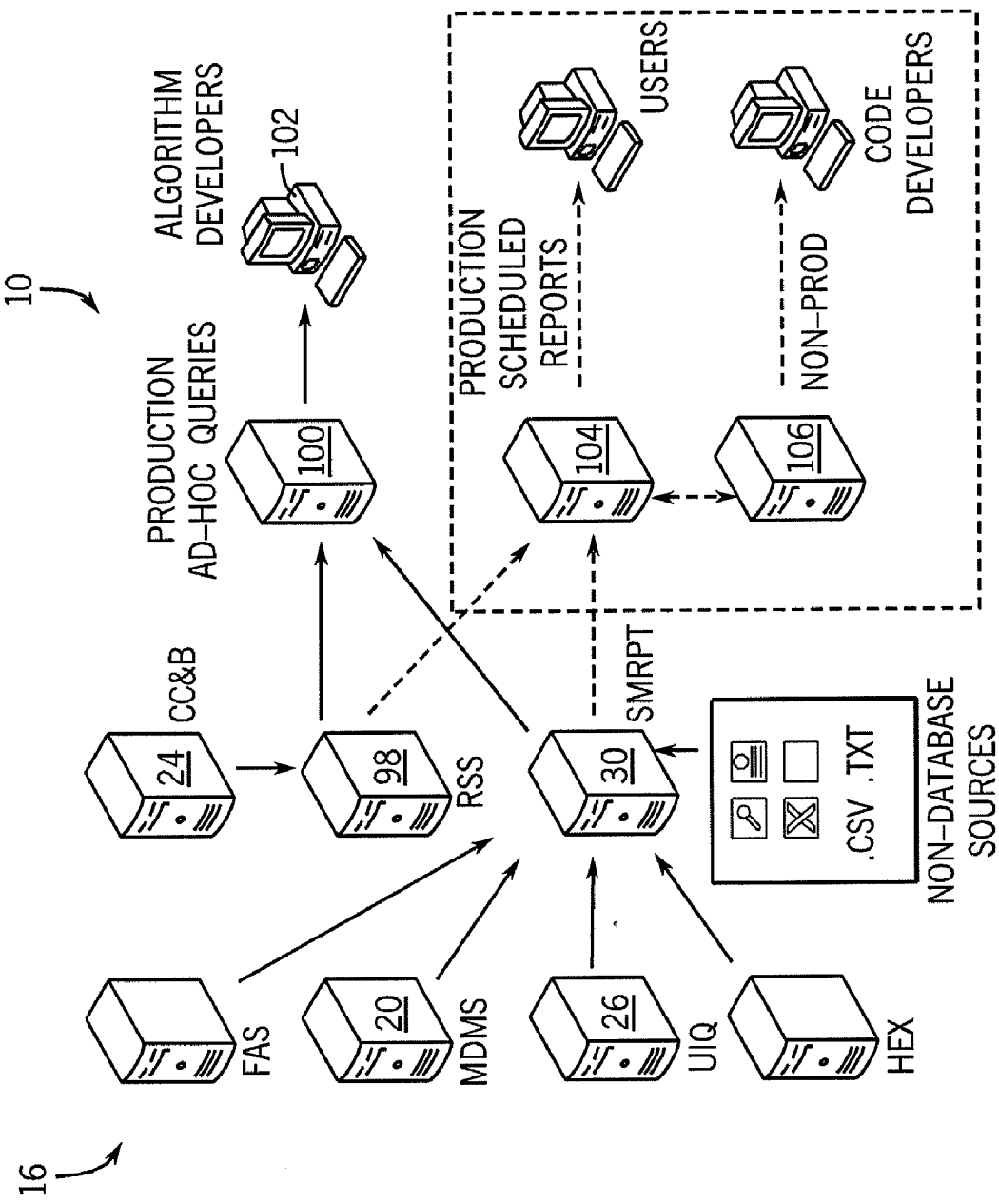

10
16
ALGORITHM DEVELOPERS
102
PRODUCTION AD-HOC QUERIES
100
CC&B
24
98
RSS
30
SMRPT
PRODUCTION
SCHEDULED REPORTS
USERS
104
NON-PROD
106
CODE DEVELOPERS
.CSV .TXT
NON-DATABASE SOURCES
FAS
20
MDMS
26
UIQ
HEX

FIG. 4

SYSTEM AND METHOD FOR MONITORING A UTILITY METER NETWORK

RELATED APPLICATIONS

[0001] This application claims priority under 35 U.S.C. §119 to U.S. Provisional Patent Application No. 61/451,864 filed on Mar. 11, 2011, the entire contents of which is incorporated herein by reference.

BACKGROUND

[0002] Some conventional utility meters can be used in houses and other structures to measure use gas, electricity, water, and other metered products that are billed on usage. At least some of these meters measure use and display the amount used on a dial or electric display. These passive displays may be visualized by a customer or representative from the utility provider in order to be recorded. Moreover, at least a portion of these conventional meters can be vulnerable to malicious acts by the customer or other individuals or can be susceptible to service problems. However, these problems may go undetected for certain periods of time because at least some of these conventional meters are not actively monitored, and even networked meters are often not monitored in a sophisticated manner. Monitoring of malicious and/or anomalous behavior on networks, such as utility networks, can confer benefits upon the users and operators of the network.

[0003] Additionally, detection of suspicious, malicious, and/or anomalous behavior and activities can possibly help reduce costs for users. For example, at least some utility network operators and administrators may need to increase utility rates for all customers in order to account for malicious acts by some customers leading to utility theft. By detecting at least some suspicious, malicious, and/or anomalous behavior, utility network operators and administrators and, as a result, utility customers, can avoid at least some of the costs associated with utility theft.

[0004] Furthermore, detecting at least some suspicious, malicious, and/or anomalous behavior can potentially improve utility network safety. Under some circumstances, attempting to steal utilities can involve alteration of utility meters and utility network-associated equipment. As a result, customers and others attempting to steal utilities can compromise the integrity and safety of at least some of this equipment. For example, alteration of some electrical network-associated equipment can potentially expose live electrical wires that may injure the customer, utility network employees, and/or other individuals. Moreover, alteration of some natural gas network-associated equipment can potentially create natural gas leaks, which can lead to significant harm and/or injury to neighboring individuals and property. By being able to detect at least some suspicious, malicious, and/or anomalous behavior, the utility network can attempt to reduce risks associated with unauthorized altering of utility network-associated equipment and utility meters.

SUMMARY

[0005] Some embodiments of the invention provide a security and event monitoring system for a utility meter network. In some embodiments, the monitoring system can provide an infrastructure for readily developing and implementing new monitoring applications. In some embodiments, the monitoring system can analyze and compare information from many sources such as utility meters, one or more customer billing databases, and meter event data and uses protocols to identify anomalies likely related to security violations, power outages, or service issues. In some embodiments, the monitoring system can develop a set of rules where one or more of the rules can be applied to the information and data in order to flag suspicious events indicative of such anomalies or power outages of any duration. Some embodiments of the monitoring system generate reports, including information and/or flagged suspicious events, that are available for user review, analysis, and corrective action.

DESCRIPTION OF THE DRAWINGS

[0006] FIG. **1** is a block diagram of a utility meter network including a monitoring system according to one embodiment of the invention.

[0007] FIGS. **2**A and **2**B are objects stored by the monitoring system of FIG. **1**.

[0008] FIG. **3** is an architecture diagram of the monitoring system according to one embodiment of the invention.

[0009] FIG. **4** is a partial block diagram of a utility meter network including a monitoring system according to another embodiment of the invention.

DETAILED DESCRIPTION

[0010] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of "including," "comprising," or "having" and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. Unless specified or limited otherwise, the terms "mounted," "connected," "supported," and "coupled" and variations thereof are used broadly and encompass both direct and indirect mountings, connections, supports, and couplings. Further, "connected" and "coupled" are not restricted to physical or mechanical connections or couplings.

[0011] The following discussion is presented to enable a person skilled in the art to make and use embodiments of the invention. Various modifications to the illustrated embodiments will be readily apparent to those skilled in the art, and the generic principles herein can be applied to other embodiments and applications without departing from embodiments of the invention. Thus, embodiments of the invention are not intended to be limited to embodiments shown, but are to be accorded the widest scope consistent with the principles and features disclosed herein. The following detailed description is to be read with reference to the figures, in which like elements in different figures have like reference numerals. The figures, which are not necessarily to scale, depict selected embodiments and are not intended to limit the scope of embodiments of the invention. Skilled artisans will recognize the examples provided herein have many useful alternatives that fall within the scope of embodiments of the invention.

[0012] FIG. **1** illustrates a monitoring system **10** according to one embodiment of the invention. The monitoring system **10** can include one or more applications **12** that can be stored

in a memory and is executable by a processor using one or more databases **14**. The monitoring system **10** can be in communication with a utility meter network **16** and can analyze information specific to utility meters **18** (e.g., end points) of the utility meter network **16**. In some embodiments, the monitoring system **10** can analyze the information to determine patterns that can indicate problematic utility meters **18** and possible fraudulent activity at specific utility meters **18** or within specific areas of a utility meter network **16** (e.g., suspicious, anomalous, and/or malicious events). For example, in some embodiments, the monitoring system **10** can retrieve and analyze information for all or some portions of an advanced metering infrastructure network (e.g., a smart grid network).

[0013] In some embodiments, the information can include, but is not limited to, meter data (e.g., usage data as conveyed by meters), firewall data, customer data, secondary network data (e.g., SCADA) billing data, corporate security data, smart grid network data regarding multiple meters, and/or individual meter event data. The information can be retrieved from one or more of the following components of the network **16**: utility meters or end points **18** directly (e.g., natural gas meters, electric smart meters, water meters, a network or mesh of radio frequency network access points, home area networks communicating wirelessly or using wires, etc.), a meter data management system **20**, a measure, bill, and collect data warehouse **22**, a customer care and billing database **24**, a front-end utility application suite **26**, an outage information system **28**, a smart meter operations system **30**, and any other databases, data sources, and/or data processing infrastructures that can be configured and arranged for use by the monitoring system **10**

[0014] In some embodiments, the meter data management system **20** can provide data storage and data management of meter data, such as usage data and events, collected by one or more of the utility meters **18** (e.g., via one or more automated meter reading systems). The meter data management system **20** can analyze the meter data received and can perform validation, estimation, and/or editing routines to create integrated, bill-ready data sets of the meter data. The data sets as well as a log of the editing and/or corrections made to the meter data can be stored by the meter data management system **20**, for example within a database **32**. Other applications of the network **16** can receive the data sets and other data from the meter data management system **20** for analysis, billing purposes, customer service, audits, etc.

[0015] In some embodiments, the measure, bill, and collect data warehouse **22** can act as a long-term data repository for the meter data analyzed and stored by the meter data management system **20**. For example, the meter data management system **20** can stream the data collected and the data sets created at specific intervals to the measure, bill, and collect data warehouse **22** (e.g., to a database **34** of the measure, bill, and collect data warehouse **22**). In some embodiments, the meter data can be stored for a first time period by the meter data management system **20** (e.g., about 14 months), and can be stored for a second, longer time period by the measure, bill, and collect data warehouse **22** (e.g., about 7 years). In some embodiments, one or both of the meter data management system **10** and the measure, bill, and collect data warehouse **22** can store the meter data for a period of time greater than 7 years (e.g., indefinitely). The measure, bill, and collect data warehouse **22** can be accessible by application interfaces of the network **16** for retrieval of the stored meter data (e.g., through a web service interface **36**).

[0016] In some embodiments, the customer care and billing database **24** can store customer information and billing information (e.g., within a database **38**, as shown in FIG. **1**). For example, the customer care and billing database **24** can store customer identification, corresponding smart meter location, customer credit information, account balances, account delinquency information, etc.

[0017] In some embodiments, the outage information system **28** can collect and analyze outage event data and meter restoration data. For example, the outage information system **28** can store outage data logs for outage/restoration accounting and reporting, and track and resolve outage events by time, type, and/or duration. The outage information system **28** can receive "last gasp" information from utility meters **18** as well as real time restoration notices.

[0018] In some embodiments, the monitoring system **10** can be in communication with a substation automation system (not shown) and a power distribution system (not shown) comprising power feeders. For example, in some embodiments, the power feeders can include one or more groups of meters **18** connected to one or more nodes (not shown). The monitoring system **10** can collect and analyze outage event data and meter restoration data originating from the power feeders. In some embodiments, the monitoring system **10** can process the event and meter restoration data to assess whether the groups of meters **18** experience short-lived or long-lived power outages. For example, a short-lived power outage can comprise some or all of the power outages lasting less than about five minutes and a long-lived power outage can comprise some or all of the power outages lasting longer than about five minutes. In some embodiments, the processing of some or all of this power outage data can assist an outage management team in managing performance of power feeders and other protective devices in the power distribution system.

[0019] In some embodiments, the front-end utility application suite **26** can include administrative tools, programs, applications **40**, etc. to configure, manage, and update the network **16**. In addition, in some embodiments, the front-end utility application suite **26** can substantially continuously communicate with the utility meters **18** in real time. In other embodiments, the front-end utility application suite **26** can communicate with the utility meters **18** on a periodic or as-needed basis. In some embodiments, the front-end utility application suite **26** can also include a database **42** and one or more web service interfaces **44**.

[0020] The front-end utility application suite **26** can function as an intermediary between back-end components of the network **16** and the utility meters **18**. As a result, the back-end components can acquire consistent meter data independent of the automated meter reading systems used at the utility meters **18**. For example, the front-end utility application suite **26** can acquire the meter data from the utility meters **18**. The meter data can then be transferred to the meter data management system **20** (e.g., the database **34** of the meter data management system **20**) for storage and analysis. In another example, the front-end utility application suite **26** can acquire outage event data from one or more of the utility meters **18**, which can then be transferred to the outage information system **28**.

[0021] In one embodiment, the front-end utility application suite **26** can include data analysis routines (e.g., executed by

a processor, not shown) to analyze the collected meter data prior to transferring the meter data to the meter data management system **20**. In addition, the front-end utility application suite **26** can provide communication between the back-end components and customers. For example, meter data reports, meter outage reports, and other types of reports can be produced by the back-end components and output to the front-end utility application suite **26**. Through the web service interfaces **44**, customers can request and receive such reports. In some embodiments, at least some portions of the monitoring system **10** can communicate with other information sources (e.g., databases) that include data regarding potential security risks, public records, and any other data that would be desirable when monitoring the network **16**.

[0022] In some embodiments, the monitoring system **10** can comprise one or more protective layers **25** (e.g., firewalls) between different components, as shown in FIG. **1**. For example, the interface between the meters **18** and the front-end utility application suite **26** can comprise a firewall **25**. In some embodiments, in addition to, or in lieu of, the firewall **25** between the meters **18** and the front-end utility application suite **26**, the interface between the front-end utility application suite **26** and other portions of the monitoring system **10** can comprise one or more firewalls **25**. As a result of the multiple layers of firewalls **25**, communications between different elements of the monitoring system **10** can be securely transmitted. Moreover, in some embodiments, by including multiple firewalls **25** in the system **10**, system administrators can increase their chances of detecting any attempted tampering with components of the monitoring system **10** by detecting tampering at the firewalls **25**.

[0023] In some embodiments, the smart meter operations system **30** can function as a meter reporting center that can act as an intermediary between the front-end utility application suite **26** and the some or all of the back-end components of the network **16**. In addition, in some embodiments, one or more of the actions described above in relation to each of the network **16** components may be executed by a different component or multiple components.

[0024] The data collected and analyzed by the components of the network **16** can be retrieved by the monitoring system **10** over public or private wireless and/or wired communications. For example, the monitoring system **10** can retrieve some of the information from the customer care and billing database **24** as encrypted files (e.g., RSS files) using a secured HTTP GET method (e.g., by a PULL operation by the monitoring system **10**) at predetermined time intervals (e.g., an hourly interval, a daily interval, a weekly interval, a monthly interval, or any other regular or irregular intervals). In another example, the monitoring system **10** can retrieve some of the information from the meter data management system **20** by file transfer protocol (FTP) and/or a secure file transfer protocol (SFTP) data PUT operations. In yet another example, the monitoring system **10** can retrieve some of the information from the front-end utility application suite **26** through web service Simple Object Access Protocol (SOAP) communications. Some of the information can be retrieved by the monitoring system **10** in near-real time (e.g., via SOAP communications) and some of the information can be retrieved at set time intervals (e.g., via FTP PUT and HTTP GET operations). In addition, different kinds of information can be retrieved at different time intervals, as described. For example, the monitoring system **10** can update base meter data once per day, can update meter events about every four hours, and can update meter states about every two hours. In some embodiments, at least a portion of the data transferred across the network **16** can be encrypted.

[0025] All of the information retrieved by the monitoring system **10** can be stored in the monitoring system database **14** in relation to a corresponding utility meter **18**. For example, as shown in FIGS. **2**A and **2**B, the information can be stored as multiple objects in relation to a specific utility meter. Such information can be retrieved from one or more of the utility meters **18** directly, the front-end utility application suite **26**, the outage information system **28**, the customer care and billing database **24**, and/or the meter data management system **20**. In some embodiments, some of the information retrieved can be converted to a desired format prior to being stored in the monitoring system database **14**. In addition, some of the information may be static information (e.g., meter location information), while some of the information may be dynamic information (e.g., updates and meter events information).

[0026] In some embodiments, some of the information can relate to account information for a specific utility meter **18**. The account information can be generated in extensible markup language (XML) format as an "AccountInfo" object **46**, as shown in FIG. **2**A. The monitoring system **10** can retrieve the account information from the customer care and billing database **24** such as customer identification, smart meter location, customer credit information, account balances, account delinquency information (e.g., days past due and amount past due), etc. Moreover, in some embodiments, the account information object **46** can include account identification, customer internal credit score, associated meter identification, service type, latest bill to date, balance on latest bill, balance 30 days prior to latest bill, balance 60 days prior to latest bill, other balance data, meter usage, or any other information relevant to a user's account.

[0027] In some embodiments, some of the information can relate to properties of the specific utility meter. The meter property information can be generated in XML format as an "Device" object **48**, as shown in FIG. **2**B. For example, the meter property information can include the type of meter, a network interface card (NIC) media access control (MAC) address, a serial number, whether the meter is in operation state or administrative state, the latitude and longitude of the utility meter location, the street address of the utility meter location, access points used, etc.

[0028] In some embodiments, some of the information can be stored as objects in relation to the Device object **48**, as shown in FIG. **2**B. For example, a "Meter" object **50** can include meter properties, a "Relay" object **52** (e.g., a Network Repeater and/or relay) can include properties related to any relays, such as network relays, used for communication between the utility meter **18** and the front-end utility application suite **26**, an "AP" object **54** can include properties related to any access points, such as network access points, used for communication between the utility meter **18** and the front-end utility application suite **26**, and an "APRelay" object **56** can include properties related to the access point and relay pathway between the utility meter **18** and the front-end utility application suite **26**. Also, in some embodiments, a separate object, such as the "DeviceState" object **58**, as shown in FIG. **2**A, can store information related to the state of the utility meter, including meter identification, NIC MAC address, operational state, administrative state, notes, etc.

[0029] In some embodiments, some of the information can relate to events observed by the utility meter **18**. The event information can be generated in XML format as an "Event" object **60**, as shown in FIG. **2**A. For example, the event information can include event type, event identification, an identifier of the event as it is stored in an event log database, meter identifier for meter **18** signaling the event, process date, source type, source identification, emitter type, emitter identification, job identification, severity of event, etc. In addition, an "EventInfo" object **62** can include general event information such as a group, identification, category, name, description, message template, severity, allowed source, and/or emitter of specific events.

[0030] In some embodiments, some of the information can relate to events labeled as "suspicious events". The suspicious event information can be generated in XML format as a "SuspiciousEvent" object **64**, as shown in FIG. **2**A. For example, the suspicious event information can include an identifier of the suspicious event as it is stored in an event log, the event itself, the time it was flagged as a suspicious event, notes, etc. Suspicious events can be a single meter event, multiple meter events, and/or other meter information which, according to rule sets of the monitoring system **10**, correlate with suspect patterns indicative of fraudulent use of one or more utility meters **18** and/or maintenance issues with one or more utility meters **18**, as described in further detail below.

[0031] Moreover, in some embodiments, at least some of the functions of the monitoring system **10** can be associated with representations of the objects stored by and/or processed by some elements of the system **10**. For instance, in some embodiments, the objects can be organized and represented at least partially based on data source, such as the utility network **16** (e.g., meters **18**, access points, different management systems and their associated data, including events, alters, and metrology), customers (e.g., demographics, premise, financial information, billing data, etc.), and/or other internal structures (e.g., revenue assurance models, workflow schedules, etc.). In some embodiments, some or all of these objects can be organized in different manners to achieve user needs and requirements.

[0032] FIG. **3** illustrates an architecture of the monitoring system **10** according to one embodiment of the invention. As shown in FIG. **3**, objects can be stored in the monitoring system database **14**. In addition to the objects described above, other objects such as settings **72**, OIS restorations **74**, outage events **76**, anchor reads **78**, and an import log object **80** can be stored in the monitoring system database **14**. The information stored in relation to the objects can be received through bulk data feeds **66** (e.g., HTTP GET and FTP Push) or near real-time interfaces **68** (e.g., SOAP), as described above. In some embodiments, information transfer can be executed automatically, for example at specific time intervals. In some embodiments, some or all of the previously mentioned objects can be stored within the database **14** or other databases and can be at least partially organized with several indices to optimize searching for the objects.

[0033] FIG. **3** also illustrates an object model **70** of the monitoring system **10**, including rules executed with the information stored in relation to one or more of the above-described objects. The rules can be executed in order to determine suspect patterns and flag and store suspicious events. Meter information, such as red flags (i.e., of suspicious, anomalous, and/or malicious events) **82**, main statuses **84**, event summaries **86**, event details **88**, meter details **90**, etc. can be communicated from the monitor system **10** through a web server **92**. In addition, some information can be communicated through email **96**.

[0034] For example, once suspicious events are determined by the monitoring system **10** or on specific time intervals, reports **94** of meter information can be generated in KML (keyhole markup language) format or CSV (comma separated values) format. The reports **94** can be used by an administrator or data analysis specialists of the monitoring system **10** to determine where physical inspection, or further investigation, of utility meters **18** may be necessary. For example, through a report **94** generated in KML format, utility meters **18** flagged with suspicious events can be plotted on electronic maps, for example, Google Earth®. Groups or clusters of utility meters **18** flagged with suspicious events shown in Google Earth® can indicate fraudulent activity in that area, enabling scheduling of prompt physical examination of the utility meters **18** in that area. For example, some system **10** administrators and utility employees can view at least some of the electronic maps on mobile devices such as, but not limited to, mobile telephones, smart phones, portable computers, tablet computers, personal digital assistants, laptops, and any other device configured and arranged for portability when physically inspecting utility meters **18**. In another example, reports **94** can be generated in a prioritized manner, such as by days left in billing cycle so that problematic meters **18** can be attended to and fixed prior to the next billing cycle.

[0035] In some embodiments, the reports can be generated on a regularly scheduled basis. In some embodiments, an administrator of the monitoring system **10** can request specific or custom reports **94** to be generated. For example, the administrator can request a report **94** specific to a single utility meter **18** or to a group of available utility meters **18** in a specific area. In another example, the administrator can request a report **94** specific to one or more business customers. The monitoring system **10** can filter the information using the parameters requested by the administrator and generate a specific report **94**, for example in near-real time rather than on a next scheduled report generation date (e.g., the monitoring system **10** can generate one or more "on-demand" reports **94**). The reports **94** can also be used by revenue assurance groups, smart meter operations groups, smart meter information security groups, smart meter distribution outage analysis groups, energy demand marketing groups, etc. In addition, reports **94** can be communicated to customers through end-user interfaces via the web server **92**. In some embodiments, in the case of suspicious events that may be illegal activity, the reports **94** can be communicated to local authorities (e.g., police enforcement, prosecutor's office, etc.) for potential prosecution of crimes. In some embodiments, reports **94** can be generated automatically by one or more applications, as discussed below. Moreover, in other embodiments, reports **94** can be generated automatically and/or manually by a system **10** user.

[0036] In some embodiments, the monitoring system **10** can be configured and arranged to provide resources for discovering potentially malicious exploitation of the network **16**. For example, the network **16** and/or the monitoring system **10** can comprise one or more deceivingly vulnerable resources that may appear attractive for potential attacks and/or depositing malicious software (e.g., the system **10** can comprise a "honeypot" resource). An individual or system attempting to gain access to the system **10** or network **16** via the deceivingly vulnerable resource can be readily discover-

able by system administrators. As a result, system administrators can attempt to stop the individual or system and/or collect information related to the attempted intrusion to develop additional analytical capabilities.

[0037] For example, in some embodiments, the deceivingly vulnerable resources can appear as a portion of the network **16** (e.g., a network node) to some outside individuals or systems. The vulnerable resources can include a network interface that can function as an interface between the resources and the network **16** (e.g., the interface can enable peer-to-peer communications and other communications with other network **16** resources). In some embodiments, the network **16** and/or monitoring system **10** can comprise an analysis engine that can receive data (e.g., encrypted data) from the resources via the network interface. The analysis engine can decode any encrypted data and analyze the data to assess whether any attempted access to the vulnerable resources is authorized and can also transmit reports or other data (e.g., packet data, decoding information, timestamps, metadata, etc.) to a backhaul network interface.

[0038] In some embodiments, the backhaul network interface can be configured and arranged to securely transmit notice of any unauthorized access attempts to a business processing and alerting system. For example, the backhaul network interface can receive secure data from the analysis engine and can reformat the received data for secure delivery across a backhaul network (e.g., an out-of-band network) to the business processing and alerting system. In some embodiments, the backhaul network can comprise a wired and/or wireless configuration.

[0039] The business processing and alerting system can be configured to process the data from the analysis engine and alert, dispatch, respond, and control any other functions of the vulnerable resources. Moreover, in some embodiments, the business processing and alerting system can be configured to remotely manage, upgrade, and/or control the vulnerable resources, provide timely dispatch of alerts transmitted by the analysis engine, and integrate into any other network **16** and/or monitoring system **10** processes already in place.

[0040] As described above, one or more rules can be applied by the monitoring system **10** using information from the monitoring system database **14** in order to assess, analyze, spot, and/or flag suspicious events. Generally, the following steps describe an example cycle of the monitoring system **10**: meter events and data are collected (e.g., periodically and/or continuously); the meter events and data are analyzed according to rules to determine patterns and correlations indicative of suspicious events; the results of the analysis as well as the meter events and data are stored; and the stored results and/or events and data are published (e.g., through reports **94** and/or website interface queries). In some embodiments, the monitoring system **10** can execute one or more of these steps at the same time.

[0041] In some embodiments, rules can be applied at regular or irregular time intervals (e.g., about every twenty minutes). Also, in some embodiments, suspicious events that may already be flagged for a specific meter **18** may or may not be re-flagged, depending on the type of suspicious event. In addition, in some embodiments, additional rules can be developed and added to the monitoring system **10** in response to flagged suspicious events or additional information retrieved from reports **94** generated by the monitoring system **10** (e.g., providing a dynamic production environment). Additionally, in some embodiments, one or more of the databases can comprise a great enough size to accommodate out-of-order events so that the monitoring system **10** can process potentially correlative activity when new data (e.g., data received that is potentially out-of-order relative to previously stored data) is received. As a result, the monitoring system **10** can continue to process in-order and out-of-order data and objects to detect any potentially previously uncorrelated anomalous and/or suspicious conditions.

[0042] For example, FIG. **4** illustrates a partial block diagram of the network **16** according to another embodiment of the invention. As shown in FIG. **4**, data feeds **98** (e.g., RSS feeds) as well as data and/or objects collected by a smart meter reporting system (e.g., the smart meter operations system **30** of FIG. **1**) can be queried in an ad-hoc fashion by a production server **100** of the monitoring system **10**. System developers **102** and/or administrators of the monitoring system **10** can analyze the queried data in order to refine and develop new rules for the monitoring system **10**, as well as discover types of suspicious events that have not been flagged. In addition, as shown in FIG. **4**, data feeds **98** as well as data collected by the smart meter report system **30** can be provided to other servers **104**, **106** of the monitoring system **10** for report generation for users, consumers, administrators, and/or code developers of the monitoring system **10**.

[0043] In some embodiments, at least a portion of the following rules can be apportioned into categories. For example, in some embodiments, the monitoring system **10** can apply one or more rules to analyze some or all of the objects using a geospatial analysis, including a k-dimensional tree analysis to assess event anomalies, network **16** misconfigurations based on geographic disparity calculations, and movement of some or all of the objects (e.g., via a time-based geographic analysis). In some embodiments, the monitoring system **10** can also apply an event-based analysis of objects that can include correlation of event data among and between similar and disparate object types, a historical analysis of data based on a given set of objects, and an analysis of events based on volume and/or frequency of a given set of events. In some embodiments, the monitoring system **10** can also apply a time-based analysis of objects including a change in event volume over a predetermined time period both independently and relative to another object or set of objects.

[0044] The following paragraphs describe example rules that can be used by the monitoring system **10** in some embodiments. Furthermore, in some embodiments, these rules can be applied on a predetermined basis (e.g., daily, hourly, monthly, etc.) after the monitoring system **10** analyzes a set of potential issues and removes potential issues that may have been noted one or more times (e.g., the monitoring system **10** can be configured to remove duplicate issues prior to further analysis). Moreover, as previously mentioned, in some embodiments, the monitoring system **10** can analyze new data and objects as they are received and the monitoring system **10** can also analyze previously received data in the context of more-recently received data to ensure detection of anomalous and/or suspicious correlations.

[0045] In some embodiments, the monitoring system **10** can include rules to assess whether a disconnected meter **18** has been reconnected without monitoring system **10** knowledge or authorization (i.e., an "Unauthorized Reconnection" rule). The monitoring system **10** can employ rules to assess whether a meter **18**, which has already been disconnected by the system **10** or otherwise disconnected by the utility provider, has been reconnected to the network **16**. For example,

the meter **18** or other portions of the network **16** can comprise a remote disconnect switch (e.g., a device that the network **16** or monitoring system **10** can use to remotely deactivate a meter **18**) that can detect whether the meter **18** has been connected to an alternate energy source (e.g., the switch can detect load-side voltage that is out of phase) or the remote disconnect switch can detect a bypass condition (e.g., the switch can detect a load-side voltage in phase). As a result of the remote disconnect switch detecting these event, the monitoring system **10** can indicate potential tampering to system administrators so that the meter **18** can be investigated.

[0046] In some embodiments, the monitoring system **10** can employ the Unauthorized Reconnection rule in the following steps. For example, if a portion of the monitoring system **10** (e.g., the remote disconnect switch) detects a load-side voltage (e.g., the meter **18** is active) to a meter **18** that has been previously disconnected, the monitoring system **10** can: query the customer care and data billing data warehouse **22** to assess and/or verify the remote disconnect date (e.g., to assure that the date has passed and the utility meter **18** should be inactive); query the front-end utility application suite **26** to assess and/or verify if the disconnection worked and if the meter **18** is actually deactivated; assess event summaries **86**, event details **88**, and any other information and/or object stored in relation to the meter **18** (e.g., notes and field activities) to determine whether a payment was received and service was reconnected; and query one or more of the databases **14**, **32**, **34**, and **38** to determine whether a new customer-of-record has reactivated the meter **18**. If there is no explanation for the load-side voltage, the monitoring system **18** can indicate tampering may have occurred so that a physical inspection can be ordered.

[0047] In some embodiments, the monitoring system **10** can include an "Uncommunicative Remote Disconnect Switch" rule. For example, some suspicious events may arise as a result of a person destroying, disconnecting, or otherwise disabling the remote disconnect switch, although, at times, the remote disconnect switch may be disabled due to no malfeasance on the party of any person (e.g., the remote disconnect switch was unintentionally damaged). As a result, the remote disconnect switch may become uncommunicative and unreachable by the monitoring system **10**. In some embodiments, when the monitoring system **10** is unable to communicate with the remote disconnect switch and the meter **18** is supposed to be in an inactive state, the monitoring system **10** can: query the customer care and data billing data warehouse **22** to assess and/or verify the remote disconnect date (e.g., to assure that the date has passed and the utility **18** should be inactive); assess event summaries **86**, event details **88**, and any other information stored in relation to the meter **18** (e.g., notes and field activities) to determine whether the meter **18** was changed or whether the meter or other portion of the end point **18** was damaged at a utility hub (e.g., a utility pole); and assess whether the meter **18** is being physically monitored by a utility employee by checking the configuration of the meter **18** as stored in one or more of the databases **14**, **32**, **34**, and **38**. If there is no explanation for the uncommunicative remote disconnect switch, the monitoring system **18** can indicate tampering may have occurred so that a physical inspection can be ordered.

[0048] In some embodiments, the monitoring system **10** can include an "Inverted Meter" rule. The monitoring system **10** can employ the Inverted Meter rule to assess the existence of a potential malfunction or whether one or more meters **18** are being operated in unauthorized manners leading to utility theft. In some embodiments, the monitoring system **10** can apply the inverted meter rule to assess situations in which the monitoring system **10** determines that structures connected to one or more meters **18** are generating energy in excess of usage so that energy is being returned to the network **16**. Under some circumstances, a structure comprising a photovoltaic system (e.g., a solar system) can produce more energy than it draws from the energy grid, and under some circumstances, portions of a meter **18** can be inverted so that, to the front-end utility application suite **26**, it appears that the customer is sending energy back to the energy grid.

[0049] In some embodiments, the monitoring system **10** can employ the Inverted Meter rule to assess whether a meter **18** registering excess energy flowing back to the energy is a result of suspicious behavior or arises for other reasons (e.g., extra energy flowing back to the grid originating from a solar system). For example, when employing the Inverted Meter rule, the monitoring system **10** can initially query the front-end utility application suite **26** to determine whether the meter **18** registering excess amounts of energy has been previously associated with any suspicious acts (e.g., prior acts of fraud or other malfeasance, such as an unreachable meter **18** or uncommunicative remote disconnect switch). Moreover, the monitoring system **10** can also assess whether the energy flowing back to the grid is substantially constant or periodic. For example, if the meter **18** is connected to a solar system, any excess energy should be generally generated when the system is exposed to sunlight. Accordingly, if the monitoring system **10** is detecting excess energy flowing back to the grid at night, the account could be flagged for physical inspection.

[0050] In some embodiments, the Inverted Meter rule can be implemented in other ways, in addition to or in lieu of some of the previously mentioned implementations. In some embodiments, the monitoring system **10** can employ the Inverted Meter rule to assess the duration of the excess energy registered by the meter **18**. For example, if the monitoring system **10** determines that the meter **18** has registered excess energy for a period of time greater than a predetermined threshold (e.g., 48 hours), then the monitoring system **10** can signal to administrators that there may be a malfunction with the meter **18** or potential tampering. Additionally, in some embodiments, the Inverted Meter rule can be implemented by the monitoring system **10** to detect use of inverted meters **18** (i.e., an unauthorized use of meters **18**) when excess energy that flows back to the grid is interrupted by a power outage followed by a restoration to the meter **18**. Accordingly, if the monitoring system **10** is detects this occurring, the account could be flagged for physical inspection.

[0051] The monitoring system **10** can include a "NIC Node Insufficient Privileges" rule. This rule can be implemented to detect a request by a NIC to the meter board, where the NIC has not provided sufficient credentials for authorization, indicating a suspicious event. For example, when a NIC attempts to communicate with a meter board, the NIC passes a shared or common password across a serial link connecting the NIC with the meter board. This password can be intended to authenticate and authorize the NIC to the meter board and to allow the retrieval of register and other data from the meter by the NIC. The suspicious event can be generated, or flagged, if the password does not provide the level of authorization required for the operation requested by the NIC. An unknown or unauthorized request to read or change data or code on the meter board may be indicative of a security attack against the

utility meter **18**. Failed authorization can be an indicator of an attempt to subvert the security controls in place between the meter **18** and the NIC, which would result in the potential for violations of confidentiality, integrity, or availability of meter data.

[0052] The monitoring system **10** can include a "NIC Authentication Failures" rule. This rule can be implemented to detect a number of consecutive authentication failures from the NIC to the utility meter **10**, indicating a suspicious event. For example, an unknown or unauthorized request to read or change data or code on the meter board can be indicative of a security attack against the meter. Failed authentication might be an indicator of an attempt to subvert the security controls in place between the meter and the NIC, which would result in the potential for violations of confidentiality, integrity, or availability of meter data.

[0053] In addition, the monitoring system **10** can include a rule to determine if a NIC is unable to communicate with a utility meter and/or a rule to determine if a NIC can not access its memory. One or both of these events occurring can indicate a problem with the NIC and/or the meter, which may require further inspection of the utility meter **18**.

[0054] The monitoring system **10** can include an "Unknown Device" rule. This rule can be implemented to detect unknown devices attempting to communicate with the front-end utility application suite **26**, indicating a suspicious event. For example, this event can be generated whenever a device unknown to the front-end utility application suite **26** is trying to communicate, such as a device with an unknown MAC address or results and information referring to an unknown access point. An unknown or unregistered device on the utility network **16** can be the result of malicious activity.

[0055] The monitoring system **10** can include an "Anomalous Behavior Detection" rule. This rule can be implemented to detect events that have been sent fewer than a threshold number of times across the entire population of events and devices on the network **16**, indicating a suspicious event. For example, the monitoring system **10** can analyze the frequency of events received by utility meters **18**, relays, and access points. When an event is sent by a device that has not been sent by a significant number of other devices performing the same function, the event can be flagged as a suspicious event. Generic anomalous detection can help detect attempts to compromise utility meters **18**, the RF mesh and communications of the network **16**, and/or back-end components of the network **16**.

[0056] The monitoring system **10** can include an "Unauthorized Shutoff" rule. This rule can be implemented to detect when a meter has processed a service disconnect (e.g., power shutoff) that does not correspond with an activity known by back-end components of the network **16**, indicating a suspicious event. For example, utility meters **18** within the network **16** can each include two associated states: administrative and operational. The administrative state can reflect what the other components of the system, such as the front-end utility application suite **26** or the customer care and billing database, have stored regarding the status of the utility meter **18**. The operational state can be the state that is reported by the utility meter **18** itself. If the utility meter **18** reports a "disconnect" or "service disconnect" state, but the back-end components indicate that the account is current and the utility meter **18** should be in an "active state", there exists a possibility of an unauthorized shutoff.

[0057] In addition, the monitoring system **10** can include one or more rules to detect general remote disconnect errors, remote disconnect communication errors, remote disconnect failing to open, remote disconnect failing to close, remote disconnect detecting alternate energy sources, remote disconnect detecting meter bypassing, service disconnect device tampering, remote disconnect switch errors, operational state unreachable, bad shut-offs, last gasps, etc.

[0058] The monitoring system **10** can include a "Meter Program Changed" rule. This rule can be implemented to detect a change to a meter program (e.g., the logic used in processing electric usage and meter events), indicating a suspicious event. For example, this event can be generated when the meter program, which records meter events, usage, and other data, changes. An unknown or unauthorized change to the meter program can be the result of tampering. The tampering, if detected in a specific timeframe among a specific set of devices, may be an indicator of a mass tampering incident. In addition, the monitoring system **10** can include a rule to detect meter data inversion, as previously mentioned.

[0059] In some embodiments, the monitoring system **10** can include other rules that can be helpful in altering system administrators to suspicious activity. For example, when a customer receives multiple utilities from one service provider (e.g., the user receives both natural gas and electricity from one provider), and the monitoring system **10** detects that the customer's meters **18** measure usage indicating that the customer is using one utility (e.g., gas) and not the other utility (e.g., electricity), the monitoring system **10** can indicate to system administrators that possible tampering has occurred. As another example, the monitoring system **10** can comprise a rule that can lead to altering system administrators when too many meters **18** are connected to a single access point that the meters **18** are not responding to queries from the monitoring system **10**, the front-end utility application suite **26**, or any other elements of the network **16**.

[0060] As described above, some of the rules can flag a suspicious event when a specific meter event happens, or when a specific meter event happens multiple, consecutive times. In some embodiments, other rules can flag suspicious events when specific meter events happen within the same time frame. In some embodiments, a suspicious event can be flagged only if a number of rules are satisfied (e.g., one rule satisfied on its own does not indicate a suspicious event, but one rule satisfied in addition to a related satisfied rule can indicate a suspicious event). In addition, rules can weigh certain meter events depending on their occurrence within a specific time interval, or their distance in relation to other utility meters reporting the same meter events. Depending on the calculated weights of specific meter events occurring relative to each other, a suspicious event can be flagged. Rules can also factor in weights for days away from billing cycles, balances overdue, credit scores, etc. when determining certain suspicious events. As a result, some rules can detect suspicious events when, for example, a cumulative score of weighted meter events and other data exceeds a threshold. In addition, some of the above-described rules may only add weight to a cumulative score, rather than each causing a suspicious event to be flagged on their own.

[0061] Further, some meter events can be disregarded when determining a suspicious event. For example, if the outage information system detects a large outage in an area (e.g., due to weather or a power failure), the outage events for each specific utility meter can be disregarded when determining a

suspicious event, such as possible fraudulent shut-down. In another example, some meter events can cause a suspicious event to be de-flagged.

[0062] The above-described databases throughout the network **16** and/or the monitoring system **10** can store rules and other data on computer-readable storage media. In addition, the above-described applications of the network **16** and/or the monitoring system **10** can be stored on computer-readable storage media. With the above embodiments in mind, it should be understood that the invention can employ various computer-implemented operations involving data stored in computer systems. These operations are those requiring physical manipulation of physical quantities. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared and otherwise manipulated.

[0063] Any of the operations described herein that form part of the invention are useful machine operations. The invention also relates to a device or an apparatus for performing these operations. The apparatus may be specially constructed for the required purpose, such as a special purpose computer. When defined as a special purpose computer, the computer can also perform other processing, program execution or routines that are not part of the special purpose, while still being capable of operating for the special purpose. Alternatively, the operations may be processed by a general purpose computer selectively activated or configured by one or more computer programs stored in the computer memory, cache, or obtained over a network. When data is obtained over a network the data may be processed by other computers on the network, e.g. a cloud of computing resources.

[0064] The embodiments of the present invention can also be defined as a machine that transforms data from one state to another state. The data may represent an article, that can be represented as an electronic signal and electronically manipulate data. The transformed data can, in some cases, be visually depicted on a display, representing the physical object that results from the transformation of data. The transformed data can be saved to storage generally, or in particular formats that enable the construction or depiction of a physical and tangible object. In some embodiments, the manipulation can be performed by a processor. In such an example, the processor thus transforms the data from one thing to another. Still further, the methods can be processed by one or more machines or processors that can be connected over a network. Each machine can transform data from one state or thing to another, and can also process data, save data to storage, transmit data over a network, display the result, or communicate the result to another machine. Computer-readable storage media, as used herein, refers to physical or tangible storage (as opposed to signals) and includes without limitation volatile and non-volatile, removable and non-removable storage media implemented in any method or technology for the tangible storage of information such as computer-readable instructions, data structures, program modules or other data.

[0065] The invention can also be embodied as computer readable code on a computer readable medium. The computer readable medium may be any data storage device that can store data, which can thereafter be read by a computer system. Examples of the computer readable medium include hard drives, network attached storage (NAS), read-only memory, random-access memory, FLASH based memory, CD-ROMs, CD-Rs, CD-RWs, DVDs, magnetic tapes, other optical and non-optical data storage devices, or any other physical or material medium which can be used to tangibly store the desired information or data or instructions and which can be accessed by a computer or processor. The computer readable medium can also be distributed over a network coupled computer systems so that the computer readable code may be stored and executed in a distributed fashion.

[0066] Although the method operations were described in a specific order, it should be understood that other housekeeping operations may be performed in between operations, or operations may be adjusted so that they occur at slightly different times, or may be distributed in a system which allows the occurrence of the processing operations at various intervals associated with the processing, as long as the processing of the overlay operations are performed in the desired way.

[0067] It will be appreciated by those skilled in the art that while the invention has been described above in connection with particular embodiments and examples, the invention is not necessarily so limited, and that numerous other embodiments, examples, uses, modifications and departures from the embodiments, examples and uses are intended to be encompassed by the claims attached hereto. The entire disclosure of each patent and publication cited herein is incorporated by reference, as if each such patent or publication were individually incorporated by reference herein. Various features and advantages of the invention are set forth in the following claims.

1. A method for monitoring a utility meter network, the method comprising:
- receiving data from a front-end utility application suite, the front-end utility application suite being in communication with one or more utility meters;
- storing the data in at least one database;
- organizing the data in the at least one database according to the utility meter from which the data originated;
- processing the data using one or more rules to detect patterns and correlations indicative of one or more suspicious events;
- storing the processed data in at least one database; and
- producing a report if patterns and correlations indicative of one or more suspicious events are detected.

2. The method of claim **1**, wherein the one or more rules comprises an Inverted Meter rule.

3. The method of claim **1**, wherein the one or more rules comprises an Unauthorized Reconnection rule.

4. The method of claim **1**, wherein the one or more rules comprises a Network Interface Card Node Insufficient Privileges rule.

5. The method of claim **1**, wherein the report comprises data that is plotted on an electronic map.

6. The method of claim **1**, wherein the data is processed using one or more rules at predetermine time intervals.

7. The method of claim **6**, wherein the predetermined time interval comprises about twenty minutes.

8. The method of claim **1**, and further comprising developing additional rules at least partially based upon patterns and correlations detected during the data processing.

9. A system for monitoring a utility network comprising:
- a utility network in communication with one or more utility meters and a front-end utility application suite, the utility network further comprising one or more of a meter data management system; a measure, bill, and collect data warehouse, an outage information system, and a smart meter operations system;

one or more databases being in communication with the utility network, the one or more databases being configured and arranged to receive and store data from the utility network; and

one or more processors being in communication with the one or more databases, the one or more processors being configured and arranged to process the stored data using one or more rules to detect patterns and correlations indicative of one or more suspicious events, and wherein the one or more processors are further configured to produce a report if patterns and correlations indicative of one or more suspicious events are detected.

10. The system of claim **9**, wherein the one or more processors are configured to develop additional rules at least partially based upon patterns and correlations detected during the data processing.

11. The system of claim **9**, wherein the one or more processors are configured to receive ad hoc queries from at least one of a system administrator and one or more servers.

12. The system of claim **9**, and further comprising one or more firewalls.

13. The system of claim **9**, wherein the one or more databases are configured to organize at least a portion of the data according to the portion of the utility network from which the data originates.

14. The system of claim **9**, wherein the one or more processors are configured to process the stored data at predetermined intervals.

15. The system of claim **9**, wherein the one or more rules comprise one or more of an Inverted Meter rule, an Unauthorized Reconnection rule, and a Network Interface Card Node Insufficient Privileges rule.

16. The system of claim **9**, wherein at least some of the rules are configured for one or more of a geospatial analysis of the data, an event-based analysis of the data, and a time-based analysis of the data.

17. A method for monitoring a utility meter network, the method comprising:

receiving data from at least one of a plurality of utility meters, a customer care and billing database, and a meter data management system;

storing one or more of the data in one or more databases;

processing at least a portion of the data using one or more rules to detect patterns and correlations indicative of one or more suspicious events; and

producing one or more reports if patterns and correlations indicative of one or more suspicious events are detected.

18. The method of claim **17**, wherein at least one of a front-end utility application suite and a smart meter operations system receive the data from the plurality of utility meters.

19. The method of claim **18**, wherein at least a portion of the data received from the one or more utility meters is queried in an ad hoc fashion by a production server to develop new rules.

20. The method of claim **17** and further comprising transmitting the one or more reports to at least one of a system administrator, a revenue assurance group, a smart meter operations group, a smart meter information security group, a smart member distribution outage analysis group, and an energy demand marketing group.

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