(72) Inventors; and
(75) Inventors/Applicants (for US only): SCOGGINS, Sean, M. [US/US]; 1406 Lyon Street, Raleigh, NC 27608 (US). MILLS, Stuart [US/US]; 1106 Oakgrove Drive, Knightdate, NC 27545 (US). MASON, Robert, T. [US/US]; 5408 Woodsnipe Drive, Raleigh, NC 27604 (US). BORLESKE, Andrew, J. [US/US]; 142 Roan Drive, Garner, NC 27529 (US). SMITH, Kathryn, J. [US/US]; 3105 E. Folkestone Place, Raleigh, NC 27604 (US). RUDRAN, Dileep [IN/US]; 408 Burgwin Wright Way, Cary, NC 27519 (US).

(54) Title: SYSTEM FOR AUTOMATICALLY ENFORCING A DEMAND RESET IN A FIXED NETWORK OF ELECTRICITY METERS
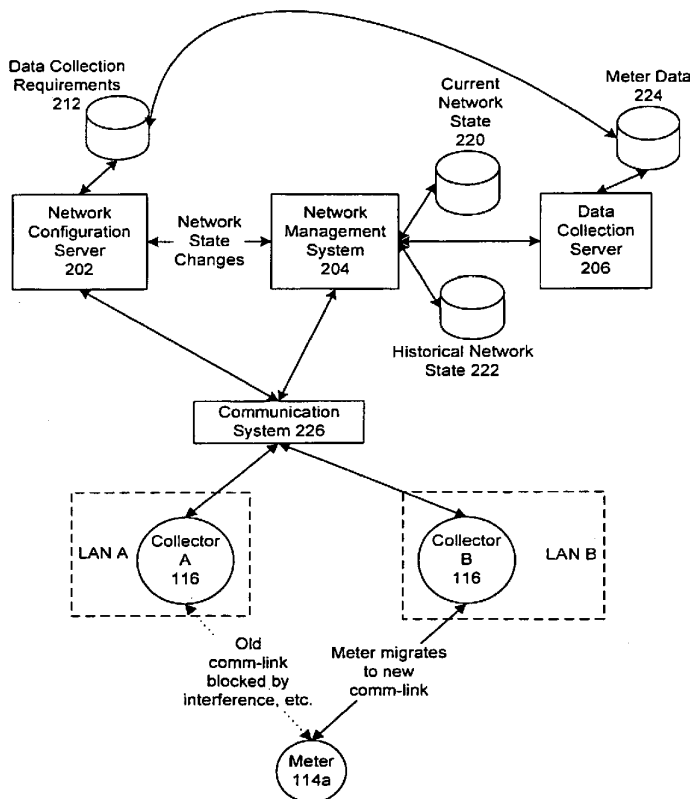
(57) Abstract: Methods and systems of enforcing a demand reset in a meter (114a) that communicates via a wireless network. When billing data is received by a server (206), it is accompanied by a demand reset counter. The counter is compared to a counter stored on the server (206). If they received counter is less than the server counter, it is determined that the meter (114a) missed a demand reset. The server (202) then instructs the meter (114a) to perform a demand reset to ensure that accurate demand data is recived by the server (206).

MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

(88) **Date of publication of the international search report:**
18 May 2006

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

SYSTEM FOR AUTOMATICALLY ENFORCING A DEMAND RESET IN A FIXED NETWORK OF ELECTRICITY METERS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001]   This application claims priority to U.S. application Serial No. 10/948,929, filed September 24, 2004, the disclosure of which is incorporated herein by reference in its entirety..

FIELD OF THE INVENTION

[0002]   The present invention relates to wireless networks for collecting data, and more particularly, to systems and methods for monitoring a demand reset count in meters that are auto-read meters.

BACKGROUND OF THE INVENTION

[0003]   The collection of meter data from electrical energy, water, and gas meters has traditionally been performed by human meter-readers. The meter-reader travels to the meter location, which is frequently on the customer's premises, visually inspects the meter, and records the reading. The meter-reader may be prevented from gaining access to the meter as a result of inclement weather or, where the meter is located within the customer's premises, due to an absentee customer. This methodology of meter data collection is labor intensive, prone to human error, and often results in stale and inflexible metering data.

[0004]   Some meters have been enhanced to include a one-way radio transmitter for transmitting metering data to a receiving device. A person collecting meter data that is equipped with an appropriate radio receiver need only come into proximity with a meter to read the meter data and need not visually inspect the meter. Thus, a meter-reader may walk or drive by a meter

location to take a meter reading. While this represents an improvement over visiting and visually inspecting each meter, it still requires human involvement in the process.

[0005] An automated means for collecting meter data involves a fixed wireless network. Devices such as, for example, repeaters and gateways are permanently affixed on rooftops and pole-tops and strategically positioned to receive data from enhanced meters fitted with radio-transmitters. Typically, these transmitters operate in the 902-928 MHz range and employ Frequency Hopping Spread Spectrum (FHSS) technology to spread the transmitted energy over a large portion of the available bandwidth.

[0006] Data is transmitted from the meters to the repeaters and gateways and ultimately communicated to a central location. While fixed wireless networks greatly reduce human involvement in the process of meter reading, such systems require the installation and maintenance of a fixed network of repeaters, gateways, and servers. Identifying an acceptable location for a repeater or server and physically placing the device in the desired location on top of a building or utility pole is a tedious and labor-intensive operation. Furthermore, each meter that is installed in the network needs to be manually configured to communicate with a particular portion of the established network. When a portion of the network fails to operate as intended, human intervention is typically required to test the effected components and reconfigure the network to return it to operation.

[0007] Thus, while existing fixed wireless systems have reduced the need for human involvement in the daily collection of meter data, such systems require substantial human investment in planning, installation, and maintenance and are relatively inflexible and difficult to manage. Therefore, there is a need for a system to manage the reading of billing data from meters to ensure that the system has the proper billing data.

SUMMARY OF THE INVENTION

[0008] The present invention is directed to methods and systems of enforcing a demand reset in a meter operating within a wireless metering network. A system in accordance with the present invention may include a network configuration server that determines a network state and a data collection server that receives meter data and a counter from the meter. When the data collection server receives the meter data and the counter, the system compares the counter to a second counter stored by the system. If the counter received from the meter is less than the second counter, the network configuration server determines that the meter has missed a demand reset and requests the meter to download the meter data and perform a demand reset.

[0009] In accordance with a feature, a first collector may be associated with a first communication path from the meter to the system. If the counter is less than the second counter,

the network configuration server instructs the first collector to contact the meter, download the meter data and perform the demand reset. Also, there may be a second collector associated with a second communication path from the meter to the system. The network configuration server may determine that the meter has migrated from the second communication path to the first communication path prior to instructing the first collector to contact the meter.

[0010] According to another feature, the meter is configured as an auto-read meter and may be instructed to perform the demand reset at a time in advance of reading the meter data. Also, the meter and the system may increment the counter and the second counter for each demand reset by the meter.

[0011] In accordance with an aspect of the invention, there is provided method for enforcing a demand reset in a meter operating within a wireless metering network. The method includes receiving meter data and a counter from a meter at a data collection server; comparing the counter to a second counter; and if the counter is less than the second counter, requesting the meter to download the meter data and perform a demand reset.

[0012] The method may also include communicating the meter data to a first collector associated with a first communication path, and instructing the first collector to contact the meter to perform the billing read and the demand reset. Optionally, the method may include determining that the meter has migrated from a second communication path having a second collector; and instructing the first collector to contact the meter after determining the meter has migrated from the second path.

[0013] The method may include configuring the meter as an auto-read meter, and instructing the meter to perform the demand reset at a time in advance of reading the meter data. The meter may be instructed in accordance with a billing date. Still optionally, the method may include incrementing the counter and the second counter for each demand reset by the meter.

[0014] Additional features and advantages of the invention will be made apparent from the following detailed description of illustrative embodiments that proceeds with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The foregoing summary, as well as the following detailed description of preferred embodiments, is better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, there is shown in the drawings exemplary constructions of the invention; however, the invention is not limited to the specific methods and instrumentalities disclosed. In the drawings:

[0016] Fig. 1 is a diagram of a wireless system for collecting data from remote devices;

[0017] Fig. 2 expands upon the diagram of Fig. 1 and illustrates a system in which the present invention is embodied;

[0018] Fig. 3 illustrates a meter migrating from one collector to another.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0019] Exemplary systems and methods for gathering meter data are described below with reference to Figs. 1-3. It will be appreciated by those of ordinary skill in the art that the description given herein with respect to those figures is for exemplary purposes only and is not intended in any way to limit the scope of potential embodiments.

[0020] Generally, a plurality of meter devices, which operate to track usage of a service or commodity such as, for example, electricity, water, and gas, are operable to wirelessly communicate with each other. A collector is operable to automatically identify and register meters for communication with the collector. When a meter is installed, the meter becomes registered with the collector that can provide a communication path to the meter. The collectors receive and compile metering data from a plurality of meter devices via wireless communications. A communications server communicates with the collectors to retrieve the compiled meter data.

[0021] Fig. 1 provides a diagram of an exemplary metering system 110. System 110 comprises a plurality of meters 114, which are operable to sense and record usage of a service or commodity such as, for example, electricity, water, or gas. Meters 114 may be located at customer premises such as, for example, a home or place of business. Meters 114 comprise an antenna and are operable to transmit data, including service usage data, wirelessly. Meters 114 may be further operable to receive data wirelessly as well. In an illustrative embodiment, meters 114 may be, for example, a electrical meters manufactured by Elster Electricity, LLC.

[0022] System 110 further comprises collectors 116. Collectors 116 are also meters operable to detect and record usage of a service or commodity such as, for example, electricity, water, or gas. Collectors 116 comprise an antenna and are operable to send and receive data wirelessly. In particular, collectors 116 are operable to send data to and receive data from meters 114. In an illustrative embodiment, meters 114 may be, for example, an electrical meter manufactured by Elster Electricity, LLC.

[0023] A collector 116 and the meters 114 for which it is configured to receive meter data define a subnet/LAN 120 of system 110. As used herein, meters 114 and collectors 116 maybe considered as nodes in the subnet 120. For each subnet/LAN 120, data is collected at collector 116 and periodically transmitted to a data collection server 206. The data collection server 206 stores the data for analysis and preparation of bills. The data collection server 206

may be a specially programmed general purpose computing system and may communicate with collectors 116 wirelessly or via a wire line connection such as, for example, a dial-up telephone connection or fixed wire network.

[0024]   Generally, collector 116 and meters 114 communicate with and amongst one another using any one of several robust wireless techniques such as, for example, frequency hopping spread spectrum (FHSS) and direct sequence spread spectrum (DSSS). As illustrated, meters 114a are "first level" meters that communicate with collector 116, whereas meters 114b are higher level meters that communicate with other meters in the network that forward information to the collector 116.

[0025]   Referring now to Fig. 2, there is illustrated a system 200 in which the present invention may be embodied. The system 200 includes a network management server 202, a network management system (NMS) 204 and a data collection server 206 that together manage one or more subnets/LANs 120 and their constituent nodes. The NMS 204 tracks changes in network state, such as new nodes registering/unregistering with the system 200, node communication paths changing, etc. This information is collected for each subnet/LAN 120 and are detected and forwarded to the network management server 202 and data collection server 206.

[0026]   In accordance with an aspect of the invention, communication between nodes and the system 200 is accomplished using the LAN ID, however it is preferable for customers to query and communicate with nodes using their own identifier. To this end, a marriage file 208 may be used to correlate a customer serial number, a manufacturer serial number and LAN ID for each node (e.g., meters 114a and collectors 116) in the subnet/LAN 120. A device configuration database 210 stores configuration information regarding the nodes. For example, in the metering system 110, the device configuration database may include data regarding time of use (TOU) switchpoints, etc. for the meters 114a and collectors 116 communicating to the system 200. A data collection requirements database 212 contains information regarding the data to be collected on a per node basis. For example, a user may specify that metering data such as load profile, demand, TOU, etc. is to be collected from particular meter(s) 114a. Reports 214 containing information on the network configuration may be automatically generated or in accordance with a user request.

[0027]   The network management system (NMS) 204 maintains a database describing the current state of the global fixed network system (current network state 220) and a database describing the historical state of the system (historical network state 222). The current network state 220 contains data regarding current meter to collector assignments, etc. for each

subnet/LAN 120. The historical network state 222 is a database from which the state of the network at a particular point in the past can be reconstructed. The NMS 204 is responsible for, amongst other things, providing reports 214 about the state of the network. The NMS 204 may be accessed via an API 220 that is exposed to a user interface 216 and a Customer Information System (CIS) 218. Other external interfaces may be implemented in accordance with the present invention. In addition, the data collection requirements stored in the database 212 may be set via the user interface 216 or CIS 218.

[0028]   The data collection server 206 collects data from the nodes (e.g., collectors 116) and stores the data in a database 224. The data includes metering information, such as energy consumption and may be used for billing purposes, etc. by a utility provider.

[0029]   The network management server 202, network management system 204 and data collection server 206 communicate with the nodes in each subnet/LAN 120 via a communication system 226. The communication system 226 may be a Frequency Hopping Spread Spectrum radio network, a mesh network, a Wi-Fi (802.11) network, a Wi-Max (802.16) network, a land line (POTS) network, etc., or any combination of the above and enables the system 200 to communicate with the metering system 110.

[0030]   Demand meters within the metering system 110 are typically put onto a billing schedule by the collector 116 and the system 200. The billing schedule may be set in accordance with a billing ID for a particular meter. The demand meters are read according to the schedule to determine a quantity of power consumed at a customer location. Reading of demand meters by the system 200 is often accomplished one of two ways: (1) contact the meter, read the demand data and reset the meter in a communication session, or (2) configure the meter self-read and reset, and read the demand data at a time after the reset (i.e., the meter operates as a so-called "auto-read" meter). A demand reset begins a new demand billing period.

[0031]   In a system such as that shown in Figs 1 and 2, there are instances when only the meter's particular collector (e.g., collector A in LAN A) is aware of the meter's billing schedule. Further, the collector may not instruct the meter to perform a demand reset until 24-hours before the time when the reset is to occur (i.e., the collector instructs the meter to behave in accordance with option (2) above and the meter's billing schedule). This method of performing a demand reset/billing read advantageously eliminates the need for accurate time-keeping and calendaring in the meter, thus allowing the meter to be low cost. However, this may present problems if the meter cannot be contacted by the collector during the short period of time leading up to the demand reset. Problems in contacting the meter may be caused by a meter that has spontaneously changed collectors because of network interference, etc.

[0032] The present invention is directed to a system to overcome this problem, through an innovative use of a demand reset count (demand data sequence number) for each demand meter. When the billing data is collected from the meters, the system 200 expects that each meter has performed its auto-read with a demand reset. The system 200 has stored thereon the demand reset count for each meter. Because each meter 114a also tracks the demand reset count, the system 200 is able to compare an expected demand reset count to that received from the meter. If the expected remand reset count is one more than that received, then the system 200 is able to determine that the demand reset for the meter was missed.

[0033] For example, with reference to Fig. 3, if the meter 114a moves from collector A to collector B before the meter 114a is instructed to perform an auto-read, then collector B may not be aware of the billing date for the meter and/or the meter 114a will not perform an auto-read as expected. If a demand reset for the meter 114a was missed because the meter has changed collectors, then the present invention will instruct the meter's new collector (collector B) to synchronously reset the meter's demand registers and read the billing data from the meter 114a. This may be accomplished by using a system for managing spontaneously migrating nodes such as disclosed in Attorney Docket No. ELSE-0851, which is incorporated herein by reference in its entirety. If the operation fails, the system 200 will again contact the collector B to retry the operation until the meter data is successfully read.

[0034] While systems and methods have been described and illustrated with reference to specific embodiments, those skilled in the art will recognize that modification and variations may be made without departing from the principles described above and set forth in the following claims. Accordingly, reference should be made to the following claims as describing the scope of disclosed embodiments.

What is Claimed:

1. A system for enforcing a demand reset in a meter operating within a wireless metering network, comprising:

a network configuration server that determines a network state; and

a data collection server that receives meter data and a counter from said meter,

wherein when said data collection server receives said meter data and said counter, said system compares said counter to a second counter, and if said counter is less than said second counter, said network configuration server requests said meter to download said meter data and perform a demand reset.

2. The system of claim 1, further comprising a first collector associated with a first communication path from said meter to said system, and wherein if said counter is less than said second counter, said network configuration server instructs said first collector to contact said meter, download said meter data and perform said demand reset.

3. The system of claim 2, further comprising a second collector associated with a second communication path from said meter to said system, wherein it is determined by said network configuration server that said meter has migrated from said second communication path to said first communication path prior to instructing said first collector to contact said meter.

4. The system of claim 1, wherein said meter is configured as an auto-read meter and is instructed to perform said demand reset at a time in advance of reading said meter data.

5. The system of claim 1, wherein said meter and said system increment said counter and said second counter for each demand reset by said meter.

6. A method for enforcing a demand reset in a meter operating within a wireless metering network, comprising:

receiving meter data and a counter from a meter at a data collection server;

comparing said counter to a second counter; and

if said counter is less than said second counter, requesting said meter to download said meter data and perform a demand reset.

7. The method of claim 6, further comprising:

communicating said meter data to a first collector associated with a first communication path; and

instructing said first collector to contact said meter to perform said billing read and said demand reset.

8. The system of claim 7, further comprising:

determining that said meter has migrated from a second communication path having a second collector; and

instructing said first collector to contact said meter after determining said meter has migrated from said second path.

9. The method of claim 6, further comprising:

configuring said meter as an auto-read meter; and

instructing said meter to perform said demand reset at a time in advance of reading said meter data.

10. The method of claim 9, said instructing said meter in accordance with a billing date.

11. The method of claim 6, further comprising:

incrementing said counter and said second counter for each demand reset by said meter.

12. A computer-readable medium having computer-executable instructions for instructing a computing device to perform the steps of enforcing a demand reset in a meter operating within a wireless metering network, said steps comprising:

receiving meter data and a counter from a meter at a data collection server;

comparing said counter to a second counter; and

if said counter is less than said second counter, requesting said meter to download said meter data and perform a demand reset.

13. The computer-readable medium of claim 6, further comprising instructions for performing the steps of:

communicating said meter data to a first collector associated with a first communication path; and

instructing said first collector to contact said meter to perform said billing read and said demand reset.

14. The computer-readable medium of claim 13, further comprising instructions for performing the steps of:

determining that said meter has migrated from a second communication path having a second collector; and

instructing said first collector to contact said meter after determining said meter has migrated from said second path.

15. The computer-readable medium of claim 12, further comprising instructions for performing the steps of:

configuring said meter as an auto-read meter; and

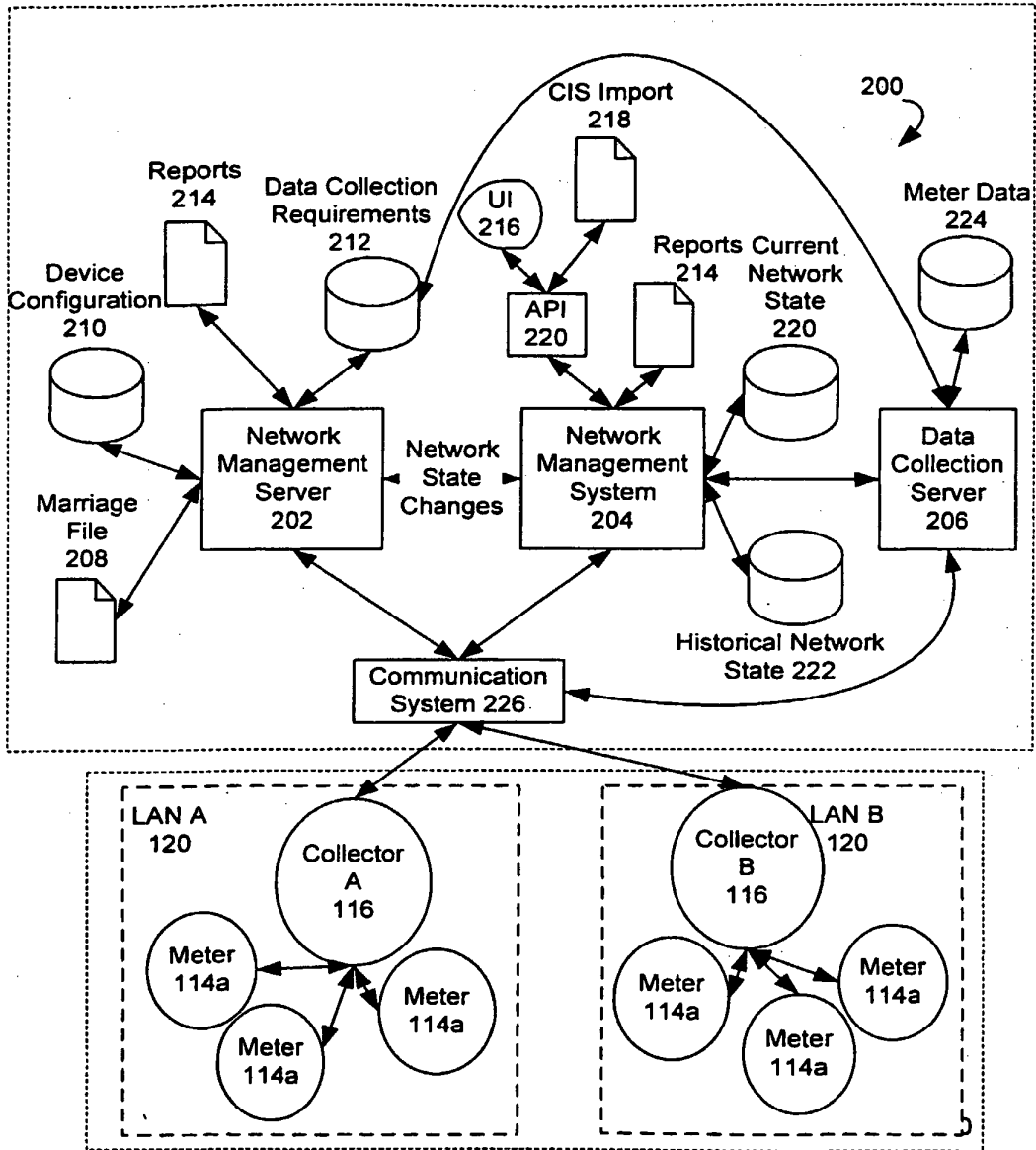instructing said meter to perform said demand reset at a time in advance of reading said meter data.

16. The computer-readable medium of claim 15, said instructing said meter in accordance with a billing date.

17. The computer-readable medium of claim 12, further comprising instructions for performing the steps of:

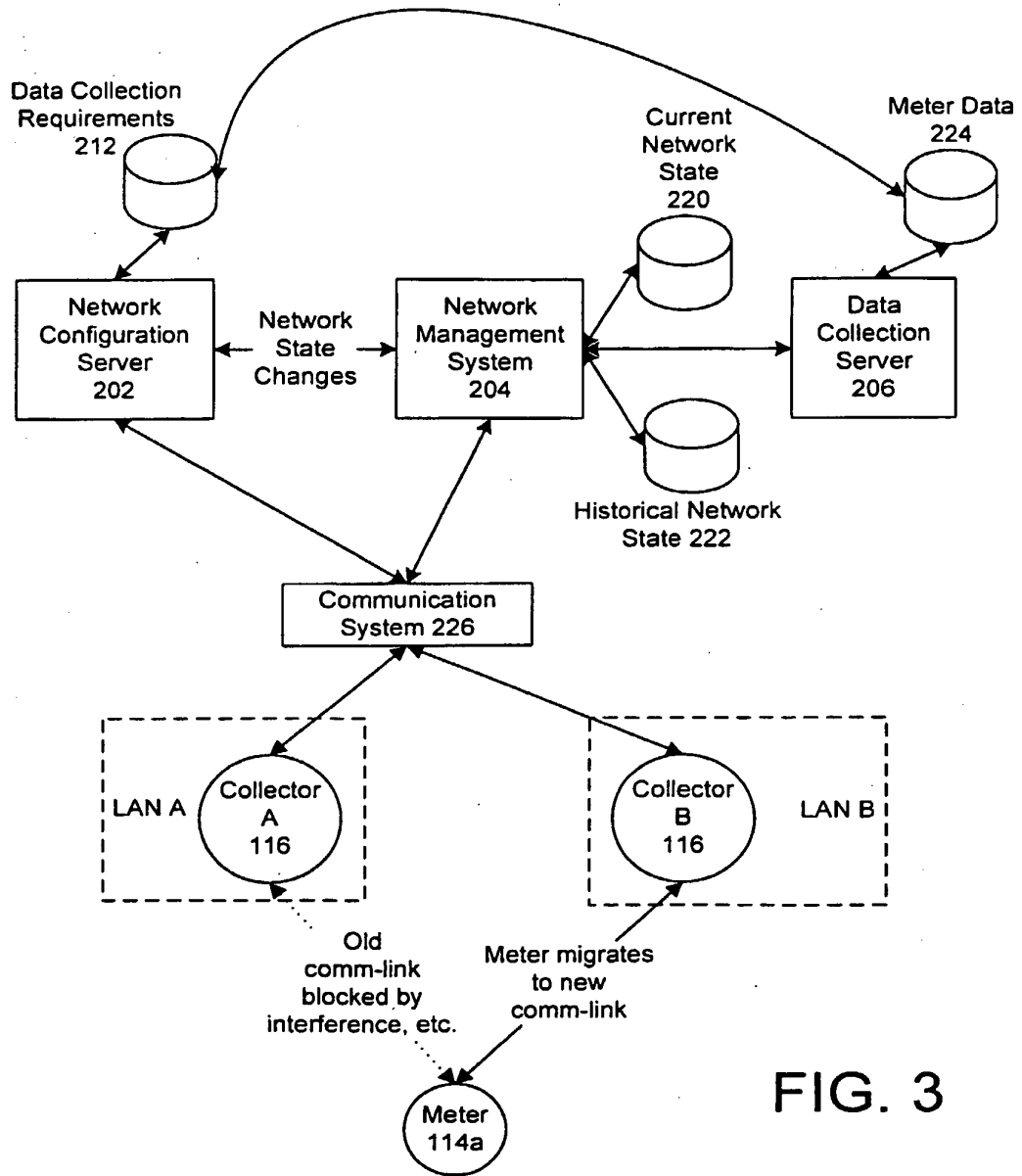incrementing said counter and said second counter for each demand reset by said meter.

1/3

FIG. 1

FIG. 2

3/3

FIG. 3