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(54) **SYSTEMS FOR AND METHODS OF ASSET MANAGEMENT IN A WASTE MANAGEMENT SERVICE ENVIRONMENT**

(75) Inventors: **Alan Sabino**, Rutland, VT (US); **Jessica Hewitt**, Queensbury, NY (US); **William Petrow**, Charlotte, VT (US)

(73) Assignee: **Casella Waste Systems, Inc.**, Rutland, VT (US)

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(52) **U.S. Cl.** **340/500**; 340/539.1; 340/539.13; 340/572.1; 340/825.36; 340/825.49

(58) **Field of Classification Search** 340/500, 340/539.1, 539.13, 572.1, 825.36, 825.49
See application file for complete search history.

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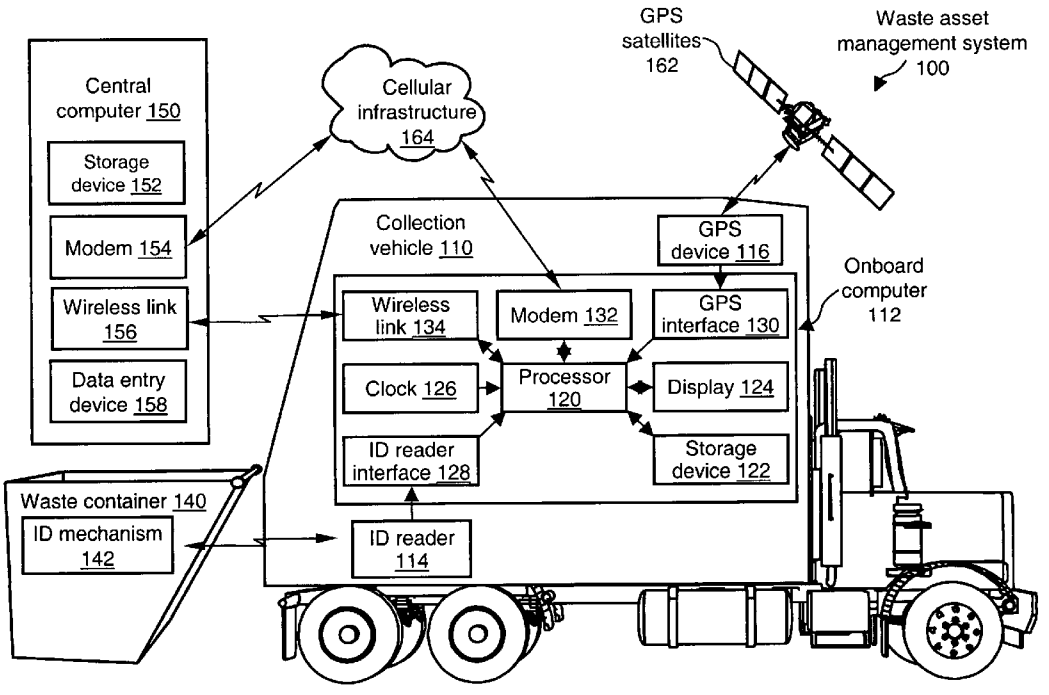
Primary Examiner—Daryl C Pope
(74) *Attorney, Agent, or Firm*—Wilmer Cutler Pickering Hale and Dorr LLP

(57) **ABSTRACT**

One embodiment of the present invention includes an identification mechanism, such as a radio frequency identification (RFID) tag or barcode, associated with a waste container. The identification mechanism contains an identifier that can be used to identify the waste container, and that can be read by a vehicle with an identification reader. In addition, the location of the waste container can be determined using a GPS receiver. The waste container identifier and its corresponding location can then be stored in a computer for later transmission to a second computer, for example, by using a wireless communication link. The second can be used to associate the waste container identifier and the waste container's position with a customer.

15 Claims, 4 Drawing Sheets



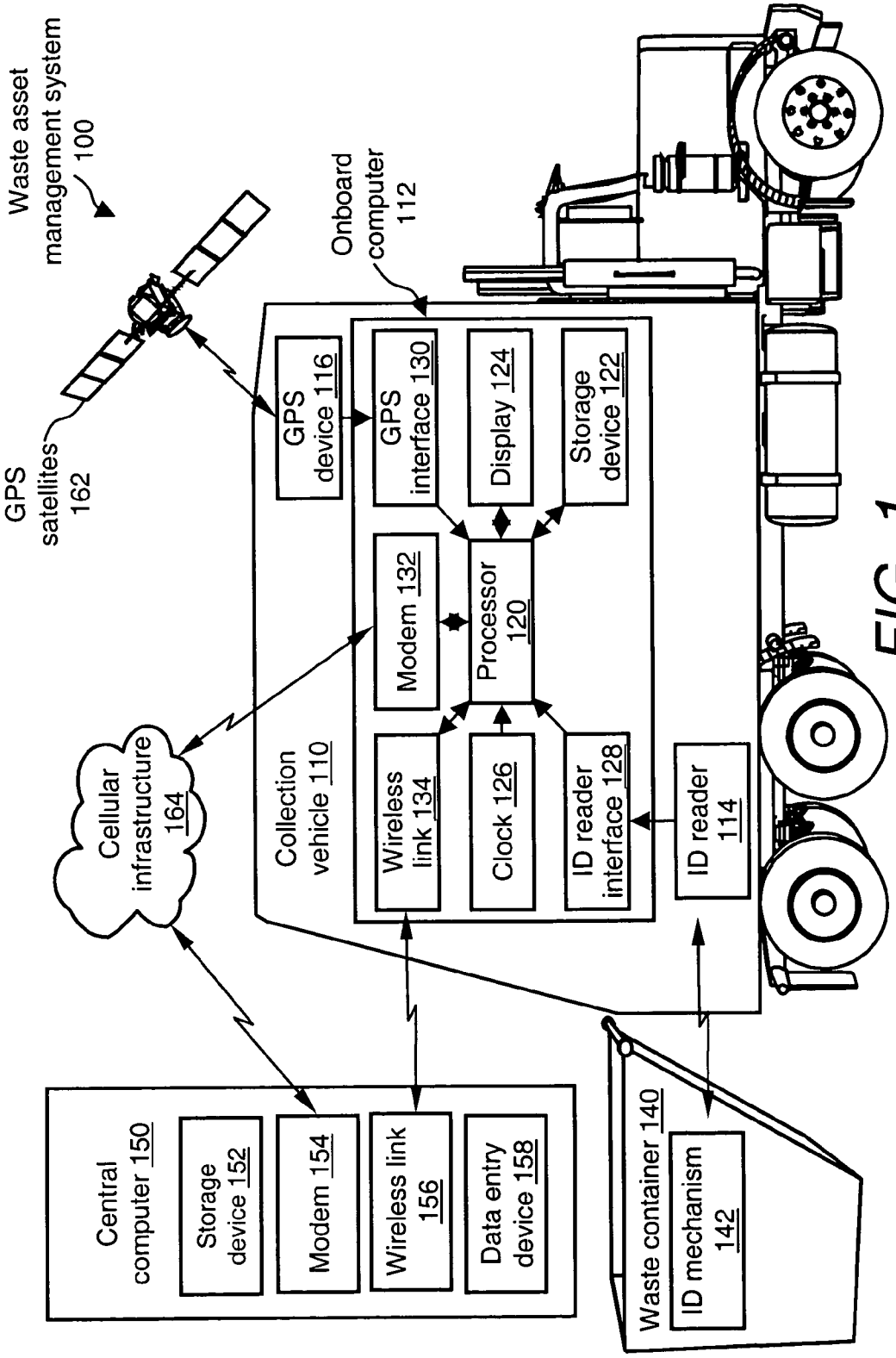

Waste asset management system 100
GPS satellites 162
Onboard computer 112
GPS device 116
GPS interface 130
Display 124
Storage device 122
Modem 132
Processor 120
Wireless link 134
Clock 126
ID reader interface 128
ID reader 114
Collection vehicle 110
Cellular infrastructure 164
Central computer 150
Storage device 152
Modem 154
Wireless link 156
Data entry device 158
Waste container 140
ID mechanism 142

FIG. 1

200

Asset ID 210	Service GPS Coordinates 230	Deployment GPS Coordinates 240	Date and Time of Container Installation 280	Date and Time of Service 290	Decommission 298
1010	34.060161, -118.280740	34.060161, -118.280740	01/15/2006 12:23:12pm	04/25/2006 2:30:02pm	No
1020	34.104343, -118.259132	34.104343, -118.259132	01/18/2006 6:15:05am	04/25/2006 6:09:02pm	Yes
1030	33.947418, -118.116589	33.947418, -118.116589	03/21/2006 9:50:50am	04/27/2006 1:37:02pm	Yes
1040	34.087071, -118.073673	34.087071, -118.073673	03/05/2006 8:37:03pm	04/27/2006 10:12:44am	No

FIG. 2A

202

204

Asset ID 210	Purchase Date 220	Service GPS Coordinates 230	Deployment GPS Coordinates 240	Customer Name and Address 250	Asset Type 260	Asset Value 270	Date and Time of Installation 280	Date and Time of Service 290	Contract Data 295	Decommission 298
1010	12/12/2006	34.060161, -118.280740	34.060161, -118.280740	Retailer A 123 Main St., Los Angeles, CA	dumpster	$500	01/15/2006 12:23:12pm	04/25/2006 2:30:02pm	$250/mo Expires 12/31/2006	No
1020	12/12/2006	34.104343, -118.259132	34.104343, -118.259132	Restaurant B 394 Food Lane Los Angeles, CA	roll-off container	$1000	01/18/2006 6:15:05am	04/25/2006 6:09:02pm	$850/mo Expires 12/31/2008	Yes
1030	01/19/2006	33.947418, -118.116589	33.947418, -118.116589	Manufacturer C 12 Industrial Park, Santa Monica, CA	rolling lift cart	$1500	03/21/2006 9:50:50am	04/27/2006 1:37:02pm	$950/mo Expires 06/15/2006	Yes
1040	02/20/2006	34.087071, -118.073673	34.087071, -118.073673	Retailer B 932 Meadow Ave., Pasadena, CA	dumpster	$600	03/05/2006 8:37:03pm	04/27/2006 10:12:44am	$150/mo Expires 04/05/2007	No

FIG. 2B

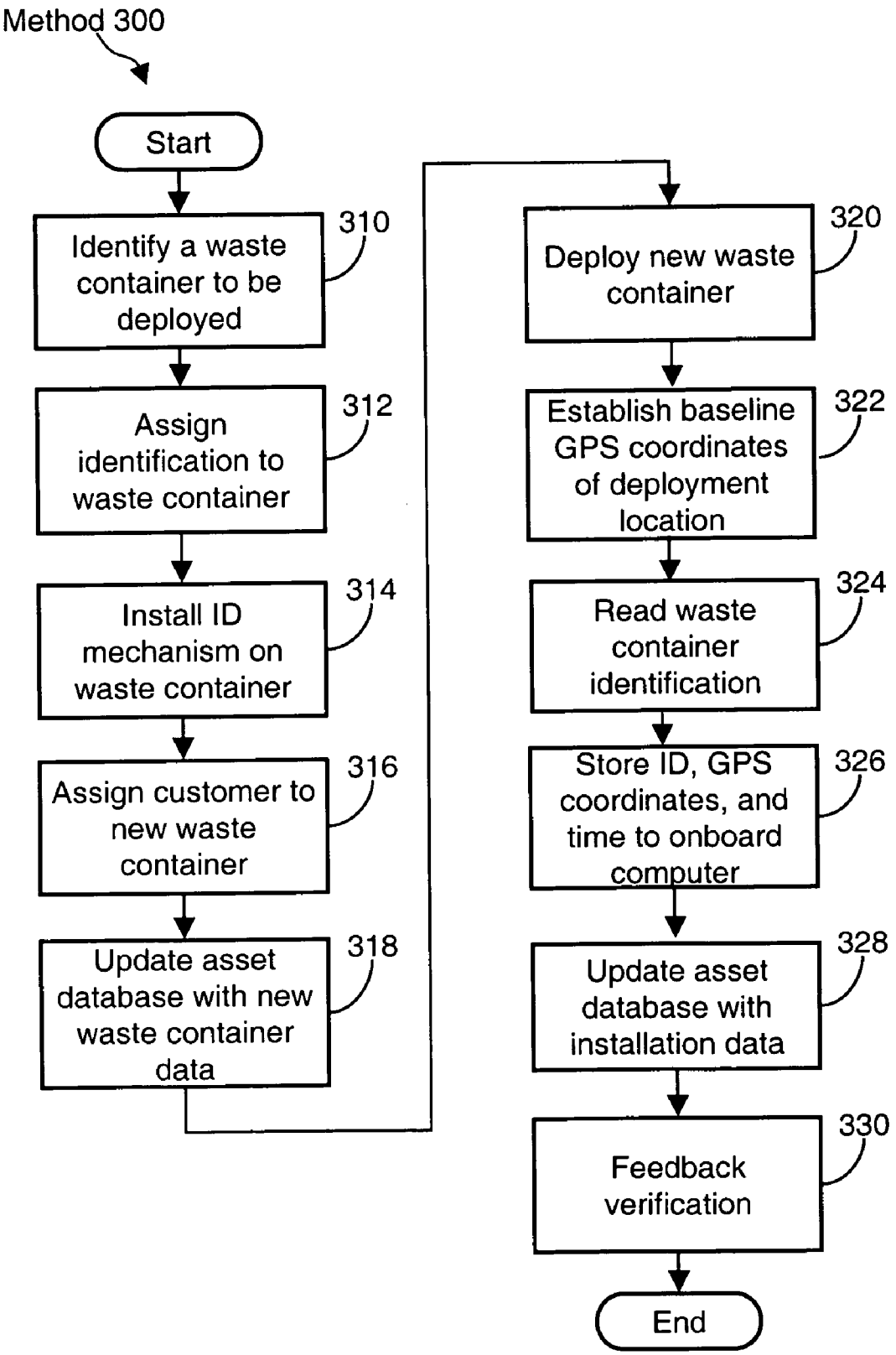

Method 300
Start
Identify a waste container to be deployed
310
Assign identification to waste container
312
Install ID mechanism on waste container
314
Assign customer to new waste container
316
Update asset database with new waste container data
318
Deploy new waste container
320
Establish baseline GPS coordinates of deployment location
322
Read waste container identification
324
Store ID, GPS coordinates, and time to onboard computer
326
Update asset database with installation data
328
Feedback verification
330
End

FIG. 3

SYSTEMS FOR AND METHODS OF ASSET MANAGEMENT IN A WASTE MANAGEMENT SERVICE ENVIRONMENT

BACKGROUND OF THE INVENTION

1. Field of the Invention

Embodiments of the present invention relate to the field of mobile asset tracking and monitoring and, more particularly, to systems for and methods of tracking and monitoring assets in a waste management service environment.

2. Background of the Invention

Commonly, in conjunction with the collection of refuse, a waste management collection service provides waste containers at a plurality of customer sites. The collection service then takes appropriate steps, generally according to a pre-established schedule, to empty the containers and remove the contents for disposal. Waste container types used by customers are diverse in the industry and include, for example, residential or commercial large-volume metal containers such as dumpsters, roll-off containers, and rolling lift (or tip) carts.

Waste containers are significant assets. A waste management collection service may deploy thousands of containers in the field, each of which typically cost several thousand dollars. This can result in an asset inventory that totals in the millions or tens-of-millions of dollars. Consequently, there is a large capital investment made by waste management collection service providers in these mobile assets.

Customer turnover and other events require that new containers be deployed and old containers be removed from service as a part of normal business operations. Unfortunately, in some cases, containers are moved without the knowledge of the waste management collection service. Presently, however, other than at initial purchase and deployment, there is no automated way to determine the location of container assets in a waste management environment.

We have determined that there exists a need to provide an automated manner in which an inventory of container assets can be created and maintained. We have also determined that there exists a need to provide a way to identify container assets deployed at customer sites, identify missing containers, and minimize any potential interruption of customer service.

LIST OF FIGURES

The Detailed Description including the description of preferred systems and methods embodying features of the invention will be best understood when read in reference to the accompanying figures wherein:

FIG. **1** is a functional block diagram of a waste asset management system in accordance with one or more embodiments of the present invention.

FIGS. **2**A and **2**B illustrate exemplary instantiations of a database that can be utilized in accordance with one or more embodiments of the present invention.

FIG. **3** illustrates an exemplary method of deployment of a waste container.

SUMMARY OF EMBODIMENTS OF THE INVENTION

Embodiments of the present invention are directed to systems for and methods of tracking and monitoring assets in a waste management service environment. Systems and methods are provided that enable a waste management service provider to create, maintain, and update an inventory of waste container assets. Additionally, systems and methods in accordance with embodiments of the present invention provide a way to identify container assets deployed at particular customer sites, identify missing containers, and reduce potential interruption of customer service.

In one embodiment of the present invention, a system for monitoring assets in a waste collection environment includes an identification mechanism, associated with a waste container, that includes a waste container identifier. A vehicle includes a reader for reading the identification mechanism and determining the waste container identifier. A computer associated with the vehicle receives and stores the waste container identifier transmitted by the reader, and further receives and stores position data associated with the waste container. A second computer receives from the computer, via wireless transmission, and stores the waste container identifier and the position data, and associates the waste container identifier with a customer.

The identification mechanism includes at least one of a radio frequency identification (RFID) tag and a barcode. The second computer may also receive, store, and associate with the waste container identifier at least one of a waste container purchase date, a street address at which the waste container is deployed, a name of the customer, an asset manufacturer, an asset model number, and an asset value. In addition, the computer records a time at which the waste container is emptied, and transmits to the second computer the time at which the waste container is emptied.

The second computer further receives, stores and associates with the waste container identifier at least one of a waste container purchase date, a street address at which the waste container is deployed, a customer name, an asset manufacturer, an asset model number, and an asset value. The computer is configured to receive global positioning system (GPS) data, which is stored as position data.

The second computer further receives, stores and associates with the waste container identifier at least one of a waste container purchase date, a street address at which the waste container is deployed, a customer name, an asset manufacturer, an asset model number, and an asset value. A wireless communication link enables the computer and the second computer to communicate, and the waste container identifier position data are transmitted using the wireless communication link.

In another embodiment of the present invention, a computer-implemented and user assisted method for monitoring assets in a waste collection environment includes providing an identification mechanism, associated with a waste container, that includes a waste container identifier. A vehicle is provided that includes a reader for reading the identification mechanism and determining the waste container identifier, and a first computer that receives and stores the waste container identifier from the reader, and position data associated with the waste container. A second computer receives, via wireless transmission, and stores the waste container identifier and the position data transmitted to the second computer by the first computer.

DETAILED DESCRIPTION OF EMBODIMENTS

FIG. **1** is a functional block diagram of a waste asset management system **100** in accordance with an embodiment of the present invention. System **100** includes collection vehicle **110** that, in turn, includes or utilizes onboard computer **112**, identification (ID) reader **114**, and Global Positioning System (GPS) device **116**. Collection vehicle **110** is a standard waste hauling truck that is used to collect and pick up

waste material from residential curbsides, community drop-off points, industrial sites, and the like.

Onboard computer **112** is a standard computing apparatus such as a laptop personal computer (PC). Alternatively, onboard computer **112** can be a PC that is physically integral with collection vehicle **110**. Computer **112** can be supplied by Glacier Computing (New Milford, Conn.) or by Mobile Computing Corp. Inc. (Mississauga, Ontario). Onboard computer **112** further includes standard components such as processor **120**, storage device **122**, display **124**, clock **126**, ID reader interface **128**, GPS interface **130**, modem **132**, wireless link **134**, and software such as the Microsoft Windows® operating system.

Processor **120** is a central processing unit (CPU) such as a Pentium™ microprocessor. Storage device **122** is a non-volatile memory, such as a hard disk drive or CD-ROM drive. Display **124** can be, for example, a standard personal computer (PC) monitor. Clock **126** is standard circuitry that can provide the calendar date and the time of day. ID reader interface **128** is an interface, such as a universal serial bus (USB) port, that allows data (e.g., RFID data) from ID mechanism **142** to be transmitted to processor **120**. In general, data stored from ID mechanism **142** will be stored as and correspond to asset ID **210**, shown in FIGS. **2**A and **2**B.

GPS interface **130** can be a standard USB port that allows GPS information, such as digital latitude and longitude, to be transmitted to processor **120**. Modem **132** is a wireless modem, such as provided by CYNET Incorporated (Houston, Tex.), that enables wireless communication through cellular infrastructure **164**. GPS satellites **162** provide GPS service to terrestrial GPS devices, such as GPS device **116**.

Cellular infrastructure **164** can include a plurality of cell towers (not shown) and other standard network infrastructure. Wireless link **134** provides wireless communication via access points (not shown) and a local area network (LAN) that may utilize or include, for example, an IEEE 802.11 network.

ID reader **114** is a commercially available RFID tag reader system, such as the TI RFID system, manufactured by Texas Instruments Incorporated (Dallas, Tex.). GPS device **116** provides position data, such as latitude and longitude, that is used to indicate the location of collection vehicle **110**. GPS data may be provided by the GEOTAB GPS system, a commercially available vehicle fleet and productivity management system manufactured by GEOTAB (Burlington, Ontario, Canada).

Waste container **140** is a standard container such as a dumpster or a roll-off container. ID mechanism **142**, which can be a standard radio frequency identification (RFID) tag or barcode, is scanned by ID reader **114**, which can be a standard RFID or barcode reader, in order to extract, for example, the identification number thereon. ID mechanism **142** is affixed to or associated with waste container **140** by a conventional method (e.g., an adhesive). The identification number is stored in the asset ID **210** field shown in FIGS. **2**A and **2**B.

Computer **150** is a standard computer, such as a PC, that includes or utilizes standard components and software such as the Microsoft Windows® operating system. Computer **150** includes or may utilize asset repository **152**, modem **154**, wireless link **156**, and data entry device **158**.

FIG. **2**A, generally at **200**, is an exemplary embodiment of a data repository that can be stored on storage device **122**. Repository **200** can be implemented using commercially available software, such as Microsoft Access®. As shown, repository **200** can include fields for asset ID **210**, service GPS coordinates **230**, deployment GPS coordinates **240**, date and time of container installation **280**, date and time of service **190**, and decommission **298**.

Deployment GPS coordinates **240** represent the GPS coordinates when a waste container **140** is initially deployed at a customer site. Although GPS coordinates are shown in decimal form, they can also be represented in degrees/minutes/seconds notation. Deployment GPS coordinates **240** are representative of the customer's address stored in customer name and address **250** field, shown in FIG. **2**B. Date and time of container installation **280** represents the date and time that waste container **140** was initially deployed at a customer site. Date and time of service **290** is recorded, for example, each time that collection vehicle **110** makes a stop at the customer and services the waste container **140**. Decommission **298** represents an indication that can be transmitted from collection vehicle **110** to repository **200** indicating that waste container **140** should be removed from service at a particular customer's site. In addition, computer **150** may provide an indication in decommission **298**, indicating, for example, that the waste container **140** at a particular customer **250** should be decommissioned because, for example, the customer's contract **295** (FIG. **2**B) is about to expire (and has not been renewed). Service GPS coordinates **230** are entered each time a customer **250** is serviced **290** and provides an indication of the present location of container **140** relative to Deployment GPS coordinates **240**. Fields within repository **200** and **202** can generally be updated in any manner at any time to reflect the dynamic realities of the marketplace.

FIG. **2**B, generally at **202**, is an exemplary embodiment of a data repository that can be stored in storage device **152**. Repository **202** can be implemented using commercially available software, such as Microsoft Access®. Repository **202** can store container asset information such as asset ID **210**, purchase date **220**, service GPS coordinates **230**, deployment GPS coordinates **240**, customer name and address **250**, asset type **260**, asset value **270**, date and time of installation **280**, date and time of service **290**, contract data **295**, and decommission **298**.

The data repository of FIG. **2**B can be linked with the data repository of FIG. **2**A using, for example, a common field associated with repository **200** and repository **202**, such as Asset ID **210** and/or Deployment GPS coordinates **240**. Purchase date **220** represents the date the container was purchased. Customer name and address **250** represents the name of a customer and their street address. This information may be used to contact a customer when necessary, such as for billing purposes. Asset type **260** represents the type of container, and can be used to properly determine the Asset value **270** for that container. Asset value **270** represents the current, or estimated, asset value. This value may be determined using straight line depreciation, or other data, such as the recent sale prices of containers of the same type and condition. Date and time of installation **280** represents when the container was installed at a customer site. Contract data **295** represents information regarding the terms of a service contract with a customer. For example, these terms may be the expiration date of the contract, the monthly rate, and/or the service schedule for container servicing.

Returning now to FIG. **1**, modem **154** is a wireless modem, such as is provided by CYNET Incorporated (Houston, Tex.). Wireless link **156** provides data communication using a wireless standard or technology such as IEEE 802.11. Data entry device **158** can be a keyboard, mouse, or touch screen.

FIG. **3** illustrates an exemplary method **300** of initial deployment of a waste container **140**.

At step **310**, a waste container **140** that is to be deployed is identified and selected for deployment. At step **312**, ID

mechanism **142** is programmed, written to, or otherwise provided with an ID number **210** that associates it uniquely with a particular waste container **140**. At step **314**, ID mechanism **142** is affixed to the waste container **140**.

At step **316**, a customer is assigned to, or associated with, a particular waste container **140**. In this step, repository **202** may be updated to associate a particular asset ID **210** field with a particular customer name and address **250** field. At step **318**, repository **202** can be populated with additional data, such as asset purchase date **220**, asset type **260**, asset value **270**, and/or contract data **295**.

An example of these data fields is shown in row **204** of FIG. **2**B. In row **204**, waste container **140** with asset ID **1010** has been assigned a purchase date of Dec. 12, 2006. At the time of purchase both the asset type **260** and the asset value **270** can be set based on the purchase data associated with the container **140**. This initial value assigned to the asset value **270** can be updated during the life of the container **140**. Contract data **295** is shown filled in with two relevant terms, the first relating to the rate charged to the customer ($250 a month), and the second to expiration date of service contact (Dec. 31, 2006).

At step **320**, waste container **140** is deployed to the customer site **250** and, at step **322**, upon or after the arrival of waste container **140** at the customer site, the deployment GPS coordinates **240** are received by onboard computer **112** and stored in repository **200** (on storage device **122**). At step **324**, prior to or while waste container **140** is unloaded from collection vehicle **110** (or another suitable vehicle) at the customer site, ID mechanism **142** is read by ID reader **114**, and asset ID **210** is stored in repository **200** in a manner such that asset ID **210** read by ID reader **114** and deployment GPS coordinates **240** are associated with each other in repository **200**. At step **326**, date and time of installation **280** is determined from clock **126**, and stored in repository **200**.

At step **328**, asset ID **210**, deployment GPS coordinates **240** and the date and time of installation **280**, each of repository **200**, are transmitted to repository **202** via wireless link **134** and wireless link **156** or, alternatively, via modem **132**, cellular infrastructure **164**, and cellular modem **156**. Alternatively, onboard computer **112** may transmit data **240** and **280** to asset repository **202** after a plurality of waste containers **140** have been deployed. The data associated with each waste container may be stored in repository **200** for a period of time, and transmitted to repository **202**, for example, after an entire shift or pick-up route of collection vehicle **110**. Row **204** shows a container with asset ID **1010** that has been updated with this type of information. Specifically, deployment GPS coordinates **240** are 34.060161, −18.280740, and the date and time of installation is Jan. 15, 2006 at 12:23:12 pm.

Since repository **202** also has an asset ID **210** field, the data associated with the asset ID **210** field of repository **200** can be transferred to the asset ID **210** field of repository **202**, for a particular container **140** having a particular asset ID associated with its ID mechanism **142**.

At step **330**, computer **150** transmits a verification message to onboard computer **112**, indicating that repository **202** has been updated. The verification is transferred via wireless link **158** and wireless link **134** or, alternatively, via cellular modem **156**, cellular infrastructure **164**, and cellular modem **132**.

Servicing of a waste container **140** occurs in a manner similar to that described in FIG. **3**. During servicing, repository **200** is updated with service GPS coordinates **230**, using on-board computer **112** and GPS device **116**. The date and time of service **290** is updated using clock **126**. These values can be used to update repository **202** in the same manner as during deployment. Further, service GPS coordinates **230** can be used by computer **150** to confirm that waste container **140** has not moved since deployment. Row **204** shows that the deployment GPS coordinates **240** corresponds to the last service GPS coordinates **230**. Updating of repository **202** may also include deriving factors such as asset value **270** at the date and time of service **290** using, for example, a straight line depreciation model. Alternatively, actual or estimated sales data of containers with the same or similar asset type **260** can be used to determine the current asset value **270**.

If during service, decommission field **298** indicates that a container is to be decommissioned, collection vehicle **110** can take the appropriate steps at a customer's site. Decommissioning may occur, for example, at the end of a contract, or when waste container needs to be replaced. Decommissioning may require removing or replacing the waste container, notifying the customer, and updating repositories **200** and **202**.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is as follows:

1. A system for tracking and monitoring a plurality of waste containers in a waste collection environment, comprising:

an identification mechanism, associated with each waste container of the plurality of waste containers, the identification mechanism comprising a waste container identifier;

a vehicle comprising:

a reader for reading the identification mechanism associated with the waste container and determining the waste container identifier,

a global positioning device for determining position data associated with the waste container, the global positioning device determining the position data when the waste container is at least one of deployed and serviced, and

a first computer receiving, via wireless transmission, and storing the waste container identifier transmitted by the reader, and further receiving and storing the position data associated with the waste container; and

a second computer receiving from the first computer, via wireless transmission, and storing the waste container identifier and the position data, and associating the waste container identifier and the position data with a customer.

2. The system of claim **1**, wherein the identification mechanism comprises at least one of a radio frequency identification (RFID) tag and a barcode.

3. The system according to claim **2**, wherein the second computer further receives, stores and associates with the waste container identifier at least one of a waste container purchase date, a street address at which the waste container is deployed, a name of the customer, an asset manufacturer, an asset model number, and an asset value.

4. The system according to claim **3**, wherein the computer records a time at which the waste container is emptied.

5. The system according to claim **4**, wherein the computer transmits to the second computer the time at which the waste container is emptied.

6. The system according to claim **1**, wherein the second computer further receives, stores and associates with the waste container identifier at least one of a waste container purchase date, a street address at which the waste container is deployed, a customer name, an asset manufacturer, an asset model number, and an asset value.

7. The system according to claim **1**, wherein the computer is configured to receive global positioning system (GPS) data, and the GPS data is stored as the position data.

8. The system according to claim 7, wherein the second computer further receives, stores and associates with the waste container identifier at least one of a waste container purchase date, a street address at which the waste container is deployed, a customer name, an asset manufacturer, an asset model number, and an asset value.

9. A computer-implemented and user assisted method for tracking and monitoring a plurality of waste containers in a waste collection environment, comprising:

providing an identification mechanism, associated with each waste container of the plurality of waste containers, comprising a waste container identifier;

providing a vehicle comprising:

a reader for reading the identification mechanism associated with the waste container and determining the waste container identifier,

a global positioning device for determining position data associated with the waste container, the global positioning device determining the position data when the waste container is at least one of deployed and services, and

a first computer receiving and storing the waste container identifier from the reader, and further receiving and storing the position data associated with the waste container; and

receiving via wireless transmission and storing at a second computer, the waste container identifier and the position data transmitted to the second computer by the first computer.

10. The method of claim 9, wherein the identification mechanism comprises at least one of a radio frequency identification (RFID) tag and a barcode.

11. The method of claim 9, further comprising receiving, storing and associating at the second computer, the waste container identifier with at least one of a waste container purchase date, a street address at which the waste container is deployed, a name of the customer, an asset manufacturer, an asset model number, and an asset value.

12. The method of claim 9, further comprising:

recording at the first computer a time at which the waste container is serviced; and

transmitting to the second computer the time at which the waste container is serviced.

13. A computer-implemented and user assisted method for deployment of a plurality of waste containers in a waste collection environment, comprising:

providing an identification mechanism, associated with each waste container of the plurality of waste containers, comprising a waste container identifier;

deploying at least one waste container of the plurality of waste containers at a predetermined location in the waste collection environment;

reading the identification mechanism associated with the deployed waste container and determining the deployed waste container identifier;

determining global positioning data of the location at which the waste container is deployed;

receiving and storing at a first computer the waste container identifier and the position data associated with the deployed waste container;

transmitting form the first computer to a second computer the waste container identifier and the position data associated with the deployed waste container; and

storing and associating at the second computer, the waste container identifier with at least one of a waste container purchase date, the global positioning data at which the waste container is deployed, a name of the customer, an asset manufacturer, an asset model number, and an asset value.

14. The method of claim 13, further comprising:

recording at the first computer a time at which the waste container is serviced; and

transmitting to the second computer the time at which the waste container is deployed.

15. The method of claim 13, wherein the first computer is an onboard computer on a vehicle.

* * * * *