

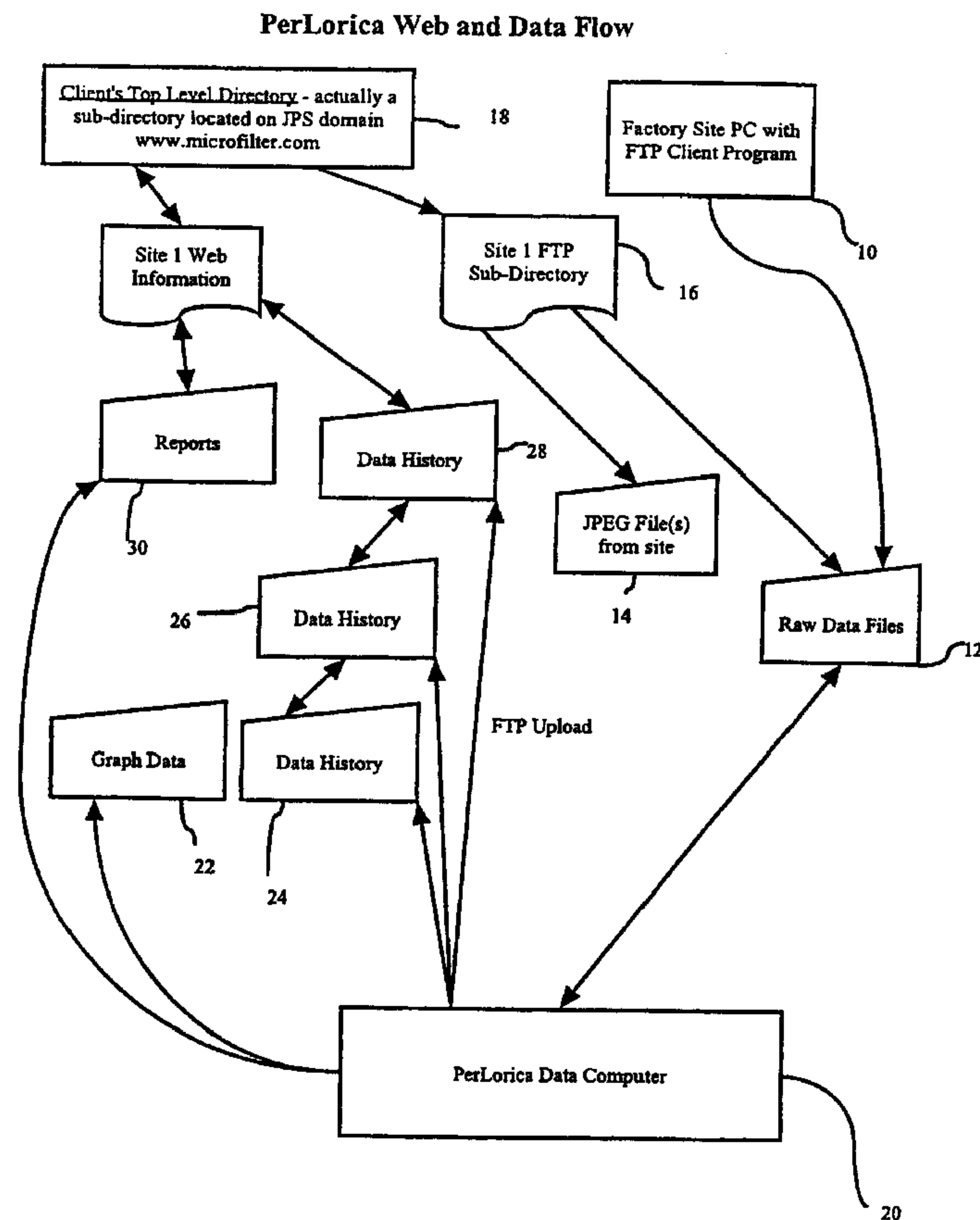


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(54) Titre : PROCEDE POUR CONTROLER DES PROCESSUS PERFECTIONNES DE SEPARATION ET/OU
D'ECHANGE D'IONS

(54) Title: METHOD FOR MONITORING ADVANCED SEPARATION AND/OR ION EXCHANGE PROCESSES



(57) Abrégé/Abstract:

A method of monitoring advanced separation and/or ion exchange processes through the collection of localized data. The data is manipulated to generate preconfigured performance, maintenance, quality assurance, quality control, regulatory, cost reports,

(57) **Abrégé(suite)/Abstract(continued):**

performance graphing and historical trends. The data is collected from sensors located at an equipment site and transferred to a remote located by use of the Internet, further all data received and used for generation of reports is also accessible by Internet connection.

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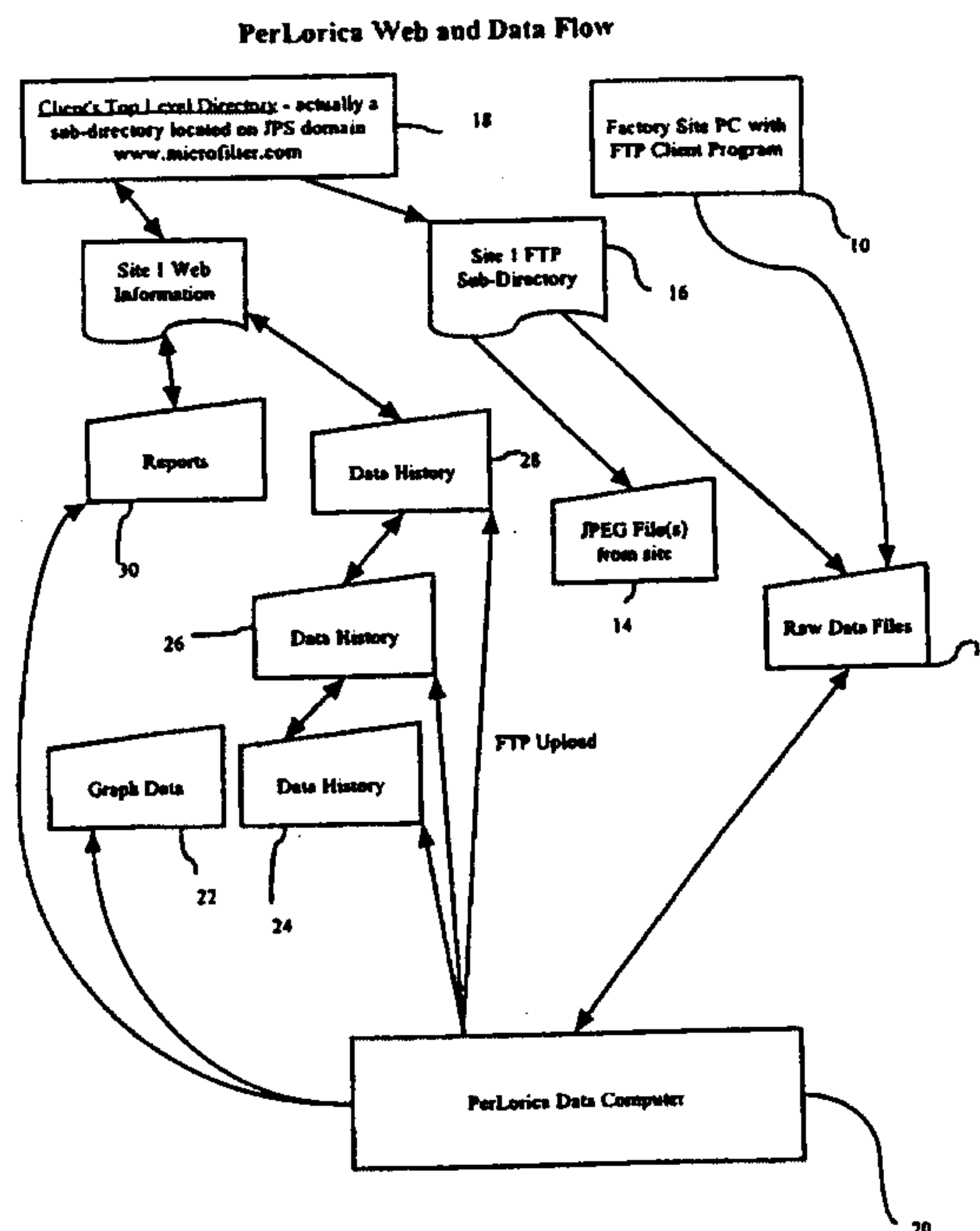
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(21) International Application Number: PCT/US99/29296 (22) International Filing Date: 9 December 1999 (09.12.99) (30) Priority Data: 09/213,781 17 December 1998 (17.12.98) US (71) Applicant: PERLORICA, INC. [US/US]; 5401 E. Horseshoe Bend, Clovis, Ca 93611 (US). (72) Inventor: WOLFE, Thomas, D.; P.O. Box 190, Rough and Ready, CA 95975 (US). (74) Agent: SLAVIN, Michael, A.; McHale & Slavin, P.A., 4440 PGA Blvd., Suite 402, Palm Beach Gardens, FL 33410 (US).		(81) Designated States: CA, MX, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>

(54) Title: METHOD FOR MONITORING ADVANCED SEPARATION AND/OR ION EXCHANGE PROCESSES



(57) Abstract

A method of monitoring advanced separation and/or ion exchange processes through the collection of localized data. The data is manipulated to generate preconfigured performance, maintenance, quality assurance, quality control, regulatory, cost reports, performance graphing and historical trends. The data is collected from sensors located at an equipment site and transferred to a remote located by use of the Internet, further all data received and used for generation of reports is also accessible by Internet connection.

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1 METHOD FOR MONITORING ADVANCED
2 SEPARATION AND/OR ION EXCHANGE PROCESSES
3

4 Field of the Invention

5 This invention is related to the field of water
6 treatment, and in particular, to a method of monitoring
7 advanced separation and/or ion exchange processes by use of
8 the world wide web allowing review of data collected and
9 complied asynchronously from a web server.

10 Background of the Invention

11 It is well recognized that nearly every aspect of
12 manufacturing, as well as life itself, is dependant upon
13 water. Water includes an infinite combination of cations
14 and anions, metals, turbidity, dissolved solids, and so
15 forth, all of which combine to form unique water
16 chemistries. Technology provides the ability to adjust,
17 reduce, or remove such constituents which can effectively
18 prepare water for use in a particular application. Proper
19 water treatment provides an economically way of conditioning
20 water to a predetermined quality level as required for the
21 particular application.

22 For instance, municipal water may be obtained from any
23 source, including seawater, all of which can be made potable
24 by use of proper water treatment equipment. A reverse
25 osmosis system, with minimal pretreatment, is capable of
26 lowering the total dissolved solids of sea water into
27 drinking water. Despite the sophistication of
28 pretreatment, improper monitoring can allow seawater to
29 quickly foul membranes. However, if the fouling is
30 monitored properly, the membranes can be easily cleaned and
31 the system will continue to run a design specifications. If
32 the fouling is not detected quickly through proper
33 monitoring, the membranes can be irreparably damaged
34 requiring partial or total membrane replacement. The cost
35 of unplanned membrane replacement, not including the
36 revenues typically associated with down time, can make such
37 a system cost prohibitive.

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1 As yet another example, water is also required for
2 steam generation in nuclear reactors. The boilers operate
3 at a super heat which requires a very high quality of water,
4 such as that produced by ion exchange. In this situation,
5 it is critical that the process system is monitored properly
6 to avoid expensive boiler cleanings and the associated down
7 time. Such systems may also include the need to monitor
8 hazardous boiler chemicals, such as hydrazine, requiring
9 highly qualified personnel.

10 Yet another example of a manufacturer requiring very
11 advanced separation and/or ion exchange processes are the
12 manufacturers of microprocessors. This type of
13 manufacturing requires an ultra-pure water quality. Again
14 it is most critical that the water treatment process system
15 is monitored properly to avoid latent defects in the
16 microprocessors.

17 Thus, no matter what water is used for, if it requires
18 advanced separation and/or ion exchange processes to obtain
19 the quality required, proper monitoring of the equipment is
20 absolutely critical. It is well recognized that the better
21 the monitoring, the water treatment system will operate
22 economically and reliably.

23 One of the problems with maintaining advanced
24 processing equipment is a need for highly qualified
25 individuals. Employment of a full time staff is costly and
26 can be problematic since such monitoring is repetitively and
27 highly qualified individuals can easily become bored. For
28 this reason, all advanced separation processes include a
29 large assortment of strategically placed sensors that are
30 typically incorporated into a computer system capable of
31 comparing the sensor values against a pre-set quality level.
32 However, if the operator does not recognize a particular
33 alarm condition, the elaborate array of monitoring equipment
34 is useless.

35

In an effort to lessen this well recognized problems, systems have been developed for use in transferring information to a remote site for back-up monitoring of the employee's duties. However, a simple remote monitor maintains the requirement that the individual monitoring the equipment is capable of determining, what he believes, is a controllable situation. This exposes a company to the expertise of a particular employee and unless the equipment owner has a secondary source to verify operation of the equipment, loss product, loss profit, and down time will still occur.

Thus, what is lacking in the art, is a means for monitoring advanced separation and/or ion exchange processes in a cost effective manner by highly trained personnel providing the consumer with a real time analysis and economic progression of their particular equipment that can be viewed and verified at any time and from any location having access to the Internet.

Summary of the Invention

The invention in one broad aspect pertains to a method of monitoring and assessing the performance of advanced separation processes in a water treatment system having a plurality of sensors to continuously monitor selected parameters from a remote location via the Internet. The method comprises the steps of: accessing a local data collection module used to capture raw data from the sensors; providing a local storage means on a local computer for storing the collected local raw data in digital data files; coupling the local computer to an Internet server computer; transmitting the data files to the Internet server computer; storing the digital data files in the memory of the Internet server computer; accessing the digital data files from a remote coupled computer; providing a software program on the Internet server computer operational to monitor and assess the performance of the water treatment system by analyzing the digital data to produce an analysis result; and providing the analysis result on the Internet server in a format suitable for access and visualization from a remote computer via a web browser.

Thus, the instant invention seeks to provide a method of compiling information from a plurality of sensors mounted to advanced separation and/or ion exchange processing equipment to generate plant process, operating and economic information accessible in near real time, from any location having access to the Internet.

Further, the instant invention seeks to provide a system that operates independent of all system controls wherein no feedback is possible to the programmable logic controller or control system and to transfer such information by a local Internet provider to a consolidating Internet address.

Yet further the instant invention seeks to provide an Internet monitoring system that can be viewed online or offline providing alarms by the use of current and historical records, providing scheduled and predicted maintenance requirements by the use of the current and historical records; providing emergency notification of failures, shutdowns, critical parameters, membrane damage by the use of electronic mail, pager, and/or human voice calling. The data is acquired from either a data capture module or by use of an improved PLC interface. Sensors are arranged to provide logical functional groupings for review and analysis (e.g. pretreatment, RO/MF train #1, /MF train #2, post treatment, ion exchange and so forth. Specific water treatment configurations include the normalization, calculations applicable to the monitoring and performance and analysis of membrane systems.

Further still, the instant invention seeks to provide a method of monitoring advanced separation and/or ion exchange processes in a relatively moderate cost to the consumer while providing information that is accurate, dependable, and near real-time by use of relatively simply architecture.

Still further, the instant invention seeks to provide a method of monitoring advanced separation and/or ion exchange processes which is independent and/or complimentary of the existing monitoring system.

Moreover the invention seeks to provide a widely understood user interface between the underlying data generated by a process system such as the production of ultra pure water for semiconductor manufacturing and the corporate managers ultimately responsible for the entire facility's operation. Although many commercially available systems make data available from process systems over the Internet, heretofore these systems have been difficult to learn to manipulate in a facile manner. The present invention overcomes these limitations by presenting data in the context of the by now familiar web browser such as Netscape Navigator™ or Internet Explorer™. This data is furthermore already analyzed and formatted in a configuration that allows even non-technical personnel to readily grasp the current state of system performance.

It is readily apparent that this same approach could easily be applied to other water using or water processing applications. For example, municipal water treatment and sewage treatment plants are ultimately the responsibility of elected officials. Yet these officials rarely have the technical training or time to allow them directly access the performance parameters of the systems for which they are responsible. The present invention could easily be used to provide a readily understandable presentation of the current performance of municipal water treatment system which was fully accessible by the elected officials at any time via the Internet. In addition, in this application of the technology, the same presentation of the system performance could be made accessible to the public at large, allowing interested members of the public to monitor the operation of their own drinking water plants as desired.

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The invention in one broad aspect provides a method for remote monitoring and assessing the performance of advanced separation processes employing an electronic control system for monitoring selected parameters. The method comprises the steps of accessing raw operating data from the electronic control system, providing a storage means on a local computer for holding the raw operating data in an electronic format, coupling the local computer to an Internet server computer, transmitting the stored raw data via the world wide web using transmission methods to a remotely located Internet server computer, storing the raw data on the Internet server computer, manipulating the raw data into an analysis result, and uploading the results of the analysis result to an Internet server in a format suitable for access and visualization with a web browser program.

Another aspect of the invention provides a method of monitoring and assessing the performance of advanced separation processes in a water treatment having system a plurality of sensors to continuously monitor selected parameters from a remote location via the Internet. The method comprises the steps of accessing a local data collection module used to capture raw data from the sensors, providing a local storage means on a local computer for storing the collected local raw data in digital data files, coupling the local computer to an Internet server computer, transmitting the data files to the Internet server computer, storing the digital data files in the memory of the Internet server computer, accessing the digital data files from a remote coupled computer, providing a software program on the Internet server computer operational to monitor and assess the performance of the water treatment system by analysing the digital data to produce an analysis result, and providing the analysis result on the Internet server in a format suitable for access and visualization from a remote computer via a web browser.

Other aspects and advantages of this invention will become apparent from the following description taken in conjunction with the accompanying drawings wherein are set forth, by way of illustration and example, certain embodiments of this invention. The drawings constitute a part of this specification and include exemplary embodiments of the present invention and illustrate various objects and features thereof.

Brief Description of the Drawings

Figure 1 is a pictorial representation of the various modules that make up the instant invention.

Figure 2 is a flow diagram of the start-up operations of the software.

Figure 3 is a flow diagram of the data acquisition operations of the software.

Figure 4 is a flow diagram of the data analysis and report generator of the software.

Detailed Description of the Preferred Embodiment

Although the invention has been described in terms of a specific embodiment, it will be readily apparent to those skilled in this art that various modifications, rearrangements and substitutions can be made without departing from the spirit of the invention. The scope of the invention is defined by the claims appended hereto.

The instant invention is a monitoring system such as shown in Figure 1 that incorporates the use of the Internet for providing a remote location for assimilation and dissemination of configured reports regarding advanced separation and/or ion exchange processes. Data is first collected by the use of sensors and on-line analytical devices from numerous locations on a water treatment system. For instance, a typical micro filter or reverse osmosis sensor group would include, but is not limited to: raw water temperature, conductivity, PH, pressure, and turbidity; permeate flow, turbidity, pressure, and conductivity; concentrate flow and

pressure as well as on/off operation of the operating pump. The data generated by the sensors and on-line liquid devices are forwarded to a data capture module or programmable controller 10 which performs the required analog to digital conversion for use in transmitting data files 12 and 14 to a main server located off-site by use of local Internet access. Data files may also be transferred by modem to a processing site. The local data capture module, or programmable controller 10, continuously scans sensor data inputs and automatically logs and archives operating data at specified intervals. System operation for real time monitoring 16 by accessing an Internet web site 18 specifically set up for a particular customer. The data is also manipulated by the data computer 20 with ftp uploads wherein operating parameters are displayed graphically via graft data 22 in a tabular format which are color coded to provide an indication of normal operation, warning status or alarm conditions. The information from the sensors are used for determining critical information for the proper evaluation of reverse osmosis membrane performance per (salt rejection, permeate flow, feed/brine average rejection and simple rejection) which is normalized in accordance with AST Standards and graphically displayed for performance evaluation, preventative maintenance, scheduling, or for trouble shooting.

Historical performance data 24 can be plotted and presented also in geographical 26 or tabular form 28 for selected periods. This provides for not only an historical analysis of system performance, but also a record of prior performance where quality control or regulatory recording purposes. In this manner, the software is designed to continuously scan sensor input and compare the current value with alarm set points in a pre-determined report 30. These set points may be different than actual locally set alarm points. For example, management may wish to see all

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1 instances where alarms were close to an alarm or trigger
2 point and such conditions may be summarized in exception
3 reports. The device further has the ability to notify
4 authorized users by E-mail or use of a pager when process
5 conditions meet or exceed, or appear likely to exceed,
6 normal alarm conditions. This provides a layer of
7 redundancy in system operation, and allows non technical and
8 management personnel to be notified promptly in the event of
9 non standard operations.

10 The customer is capable of accessing data related to
11 his processing equipment including all data, information and
12 reports by use of any computer having Internet access
13 capability. This eliminates the need for specialized
14 equipment and allows a manager operating at his desk to
15 access the data from any location whether it be the office,
16 home, or on the road without the use of specialized computer
17 systems. The software program continually updates the
18 reports for the customer or a customer may view the reports
19 or download them from the web site.

20 In the preferred embodiment, the reports are configured
21 to each customer's requirements when a service agreement is
22 established, the reports are typically generated for three
23 primary management levels: A) Process systems operations, B)
24 Plant QA/QC and C) financial oversight. For instance, the
25 process system operations would contain the information
26 necessary to monitor, maintain, supervise and trouble shoot
27 process plant system performance. In this manner the
28 typical information and parameters process block would
29 include, if applicable, flow rates, pressures, delta
30 pressures, permeate and/or ion exchange quality, ph, alarm
31 conditions, tank levels, and a graphical presentation of
32 applicable process performance parameters and trends. A
33 Plant QA/QC report would contain the information necessary
34 to enable plant managers to effectively manage downstream
35 manufacturing or distribution processes. In addition,

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1 quality assurance personnel would be able to monitor the
2 quality and quantity of the treated water to confirm
3 compliance with specifications and standards. Information
4 in this report would typically include treated water
5 production rate(flow), treated water consumption rate(flow),
6 treated water storage volume, reserve capacity (at current
7 production and consumption rates), final treated water
8 quality, reports and archive data for regulatory compliance
9 and/or QA/QC documentation.

10 Financial oversight would be through a plant economic
11 report which would contain information needed by managers
12 with profit and loss or budget responsibility to effectively
13 track the cost of operation and to identify budget
14 variances, when they occur, to permit timely corrective
15 action. In this manner, typical information parameters
16 contained in a plant economic report would include
17 calculated power consumption (expressed in kWh and actual
18 cost in local currency) and computed on the basis of user's
19 supply pump/motor efficiencies both as a year to date, as a
20 percent of the prior period, and variances both actual and
21 budget/actual versus prior period.

22 The parameter would also include calculated chemical
23 consumption (expressed in volume consumption and as
24 converted to local currency) and computed based on the
25 user's supplied chemical dose rates and integrated feed
26 water flow rates. This would be performed as a year to
27 date, as a percent of the prior period, as variances both
28 actual versus budget/actual versus prior period.

29 Calculated raw water consumption based on integrated
30 water use from feed water flow rates calculated on the year
31 to date, as a percent of the prior period, and as variances-
32 actual versus budget/actual versus prior period.

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1 Projected membrane element life to be provided
2 estimated upon the operational life remaining (based on
3 current performance and trends) and estimated sinking fund
4 value for membrane replacement.

5 Calculated/estimated overall plant efficiency may be
6 provided as a percent of theoretical efficiency. Efficiency
7 could be based on the theoretical minimum water, power, and
8 chemical consumption versus actual consumption calculated.

9 Now referring to Figure 2-4, set forth is the operation
10 of the program. This program has four essential parts - the
11 local data capture means, the data sending means, the data
12 computation and analysis, and the web server.

13 At the local site, where the process equipment is
14 located, a serial interface board is used with a local
15 computer to capture data from the process instruments
16 through the serial output of the Programmable Logic
17 Controller (PLC). A software drive specifically designed
18 for the process PLC is utilized for this application. These
19 drivers are available commercially and with the correct
20 driver and some slight modification nearly every commercial
21 PLC can be accessed. This local computer is connected to
22 the Internet either via dial up access or through a
23 dedicated corporate network.

24 A local configuration file on the local computer tells
25 the program which PLC register addresses to access, any
26 scaling factor which needs to be applied, a physical
27 description of the data being collected for example -
28 temperature or pressure, and how often the access is
29 required. The data set collected is then converted to a
30 comma delimited string value and stored locally on the hard
31 disk in a sequential file. This file may also be encrypted
32 by software if necessary.

33 At set intervals, usually in the order of 1-30 minutes,
34 the local program calls a third party control software
35 module (the data sending module) which activates the

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1 Internet connection software. Either a third party Internet
2 Service Provider is accessed via dial up connection and a
3 modem or a local network is used. The contents of the local
4 data file are then sent via ftp protocol or E-mail (smtp) to
5 either an ftp server which can be accessed by the main data
6 computer or directly to the main data computer. The local
7 computer uses the ftp access path and passwords stored on
8 its hard disk in the configuration file to determine where
9 to send the data. If the configuration file has changed
10 since the last update, this file is also sent.

11 The local computer program then transfers the contents
12 of the data file to a historical data file on the hard disk
13 providing an on site data backup source. The current data
14 file is then reused for storing new data. Typically the
15 amount of data transferred each cycle to the ftp server is
16 relatively small - several kilobytes - so that the load on
17 the network is minimal. It will also be apparent to anyone
18 skilled in the art of programming that this local computer,
19 if so desired, could also be used to access the Internet and
20 the results of main data computation could be displayed
21 locally.

22 Main Computer

23 At the main data computer, the high level program also
24 utilizes a series of configuration of "*.ini" files to
25 establish the path to where the raw data exists. This data
26 is the data which needs to be analyzed, formatted and
27 presented. The configuration file also contains the output
28 path names to the various directories used by each client
29 when they access their data via a web browser.

30 The main program loops through each data set in turn,
31 restarting as needed. Data is either accessed from the main
32 computer's hard disk or downloaded from the ftp server. The
33 configuration file allows the main program to determine which
34 data point is which part of a typical reverse osmosis or ion
35 exchange system. The configuration file also holds

1 information on which units the local process collects data.
2 For example, the configuration file may indicate that at site
3 B, the third data item in each data set is the applied feed
4 pressure expressed in kilopascals. The program must operate
5 in a consistent set of units and thus translates all pressure
6 values into the common format of pounds per square inch (psi)
7 using a units conversion sub-program. Furthermore, in this
8 example, the feed pressure is critical in determining the
9 future and current performance of the system in reference to
10 its performance when new. Furthermore, for reverse osmosis
11 membranes, changes in pressure are related to age, production
12 rate, and temperature and vice versa. Thus a change in flow
13 rate may or may not indicate that the overall system's
14 performance has changed when normalized and compared to its
15 performance when new or recently cleaned. Prior to this
16 invention, the complex mathematics for these conversions
17 required some manual intervention on the part of the operator
18 to compute the normalized conditions. The instant invention
19 does this automatically and reports normalized data to the
20 output.

21 Of course, many more process parameters are monitored,
22 normalized, and analyzed by the computer software of this
23 invention.

24 The results of these analyses are then utilized in the
25 following manner:

- 26 o Raw performance data compared to normalized or
27 corrected data is plotted in simple, easy to understand
28 graphs which are published in the jpeg or gif format
29 readily usable by a web browser.
- 30 O The performance is compared to predicted normal
31 performance and if the differential exceeds present
32 limits (found in the configuration files) selected
33 individuals are automatically sent E-mail or in more
34 extreme cases a pager or fax (paper) alert.
- 35 O Process and Economic reports are prepared from the data

13.

and published as html tables for access by a web browser.

- O Historical data is regularly updated and new graphs are prepared, in the jpeg or gif format as noted.
- O Scheduled maintenance requirements are reviewed by the software and if needed within a preset time - usually within one week, or E-mail notification is sent to the designated individual.

In either case, the output is sent to the designated web directories on a web server attached to the Internet. These directories are appropriately protected for access only by authorized individuals. It may be appreciated that the physical location of the Main Data Computer, the ftp server, and the web server may be at the same location or remote from each other. In addition mirror sites can be maintained as necessary to provide reliable service.

The main computer may be either a stand alone unit or can serve as the Internet web server in itself in addition to performing the actual computations. No particular operating system is preferred for the web server and either Windows NT™ or UNIX™ may be utilized depending on convenience, reliability, and cost issues.

It is to be understood that while I have illustrated and described certain forms of my invention, it is not to be limited to the specific forms or arrangement of parts herein described and shown. It will be apparent to those skilled in the art that various changes may be made without departing from the scope of the invention and the invention is not to be considered limited to what is shown in the drawings and described in the specification.

WHAT IS CLAIMED IS:

1. A method of monitoring and assessing the performance of advanced separation processes in a water treatment system having a plurality of sensors to continuously monitor selected parameters from a remote location via the Internet, comprising the steps of:

accessing a local data collection module used to capture raw data from the sensors;
providing a local storage means on a local computer for storing the collected local raw data in digital data files;

coupling said local computer to an Internet server computer;

transmitting said data files to said Internet server computer;

storing said digital data files in the memory of said Internet server computer;

accessing said digital data files from a remote coupled computer;

providing a software program on said Internet server computer operational to monitor and assess the performance of the water treatment system by analyzing the digital data to produce an analysis result; and

providing the analysis result on said Internet server in a format suitable for access and visualization from a remote computer via a web browser.

2. The method of monitoring advanced separation processes in a water treatment system according to claim 1, wherein said water treatment system includes an ion exchange process.

3. The method of monitoring advanced separation processes in a water treatment system according to claim 1 or 2, wherein said software program utilizes mathematical normalization and prediction routines to produce the analysis result.

4. The method of monitoring advanced separation processes in a water treatment system according to any one of claims 1-3, wherein said advanced separation processes in a water treatment system includes equipment operable to perform filtration, reverse osmosis and deionization.

5. The method of monitoring advanced separation processes in a water treatment system according to any one of claims 1-4, wherein said software program is operable to monitor and assess the performance of a reverse osmosis membrane.
6. The method of monitoring advanced separation processes in a water treatment system according to any one of claims 1-5, wherein said local data collection module includes a programmable logic controller (PLC) coupled to said sensors.
7. The method of monitoring advanced separation processes in a water treatment system according to claim 6, wherein said step of accessing a local data collection module further includes providing a serial interface card coupled to said local computer and said PLC, wherein said serial interface card is operable to transfer a serial output of raw data from the PLC to the local computer.
8. The method of monitoring advanced separation processes in a water treatment system according to claim 6 or 7, wherein said local computer includes software operable to perform the steps of reading, querying, and storing data accessed from the PLC.
9. The method of monitoring advanced separation processes in a water treatment system according to any one of claims 1-8, wherein said digital data files are transmitted to said Internet server using secure communication means.
10. The method of monitoring advanced separation processes in a water treatment system according to any one of claims 1-9, wherein said digital data files are transmitted to said Internet server via file transfer protocol (.ftp).
11. The method of monitoring advanced separation processes in a water treatment system according to any one of claims 1-9, wherein said digital data files are transmitted to said Internet server via email.

12. The method of monitoring advanced separation processes in a water treatment system according to any one of claims 1-11, wherein said software program is further operable to perform the steps of:

comparing said analysis result with predicted normal performance parameters, determining the differential between said predicted performance parameters and the analysis result, and sending notifications to pre-determined recipients if known limits for differentials are exceeded.

13. The method of monitoring advanced separation processes in a water treatment system according to claim 12, wherein said notifications are sent via email.

14. The method of monitoring advanced separation processes in a water treatment system according to any one of claims 1-13, wherein said software program is operable to analyze the performance of reverse osmosis membranes.

15. The method of monitoring advanced separation processes in a water treatment system according to any one of claims 1-14, wherein said software program is operable to monitor and assess the performance of ion exchange systems.

PerLorica Web and Data Flow

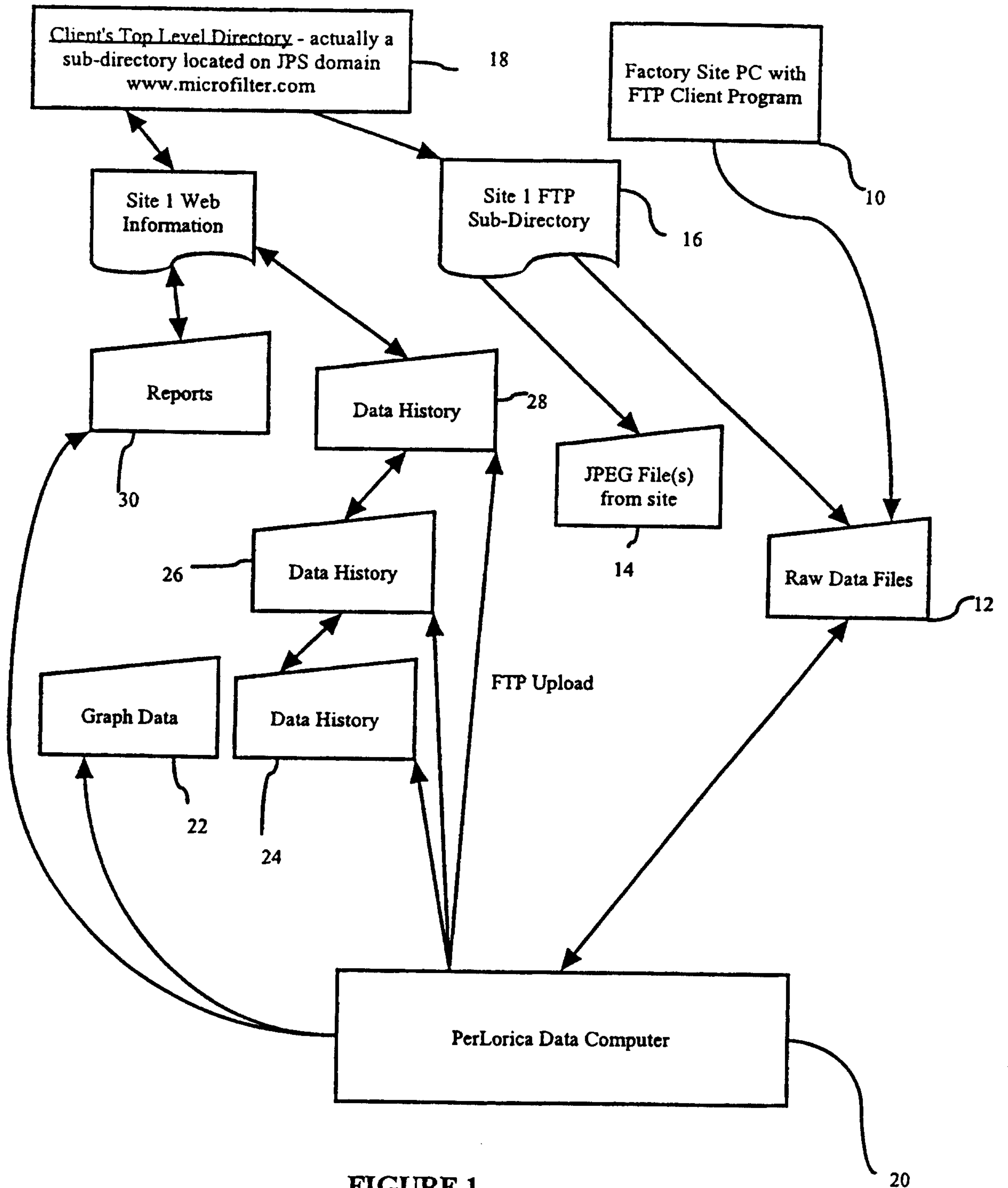


FIGURE 1

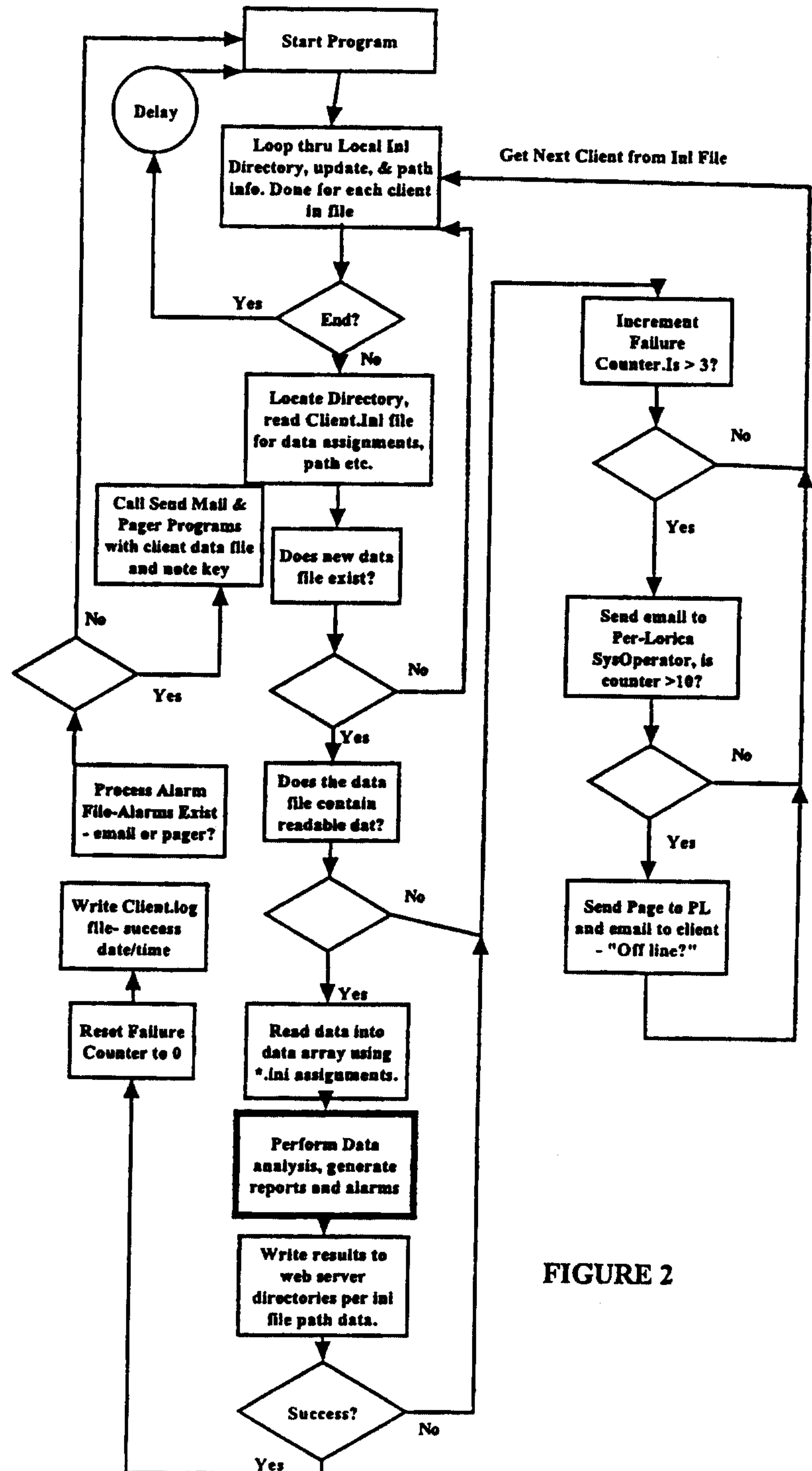


FIGURE 2

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PI-DATA-PLC Data Acquisition & FTP program

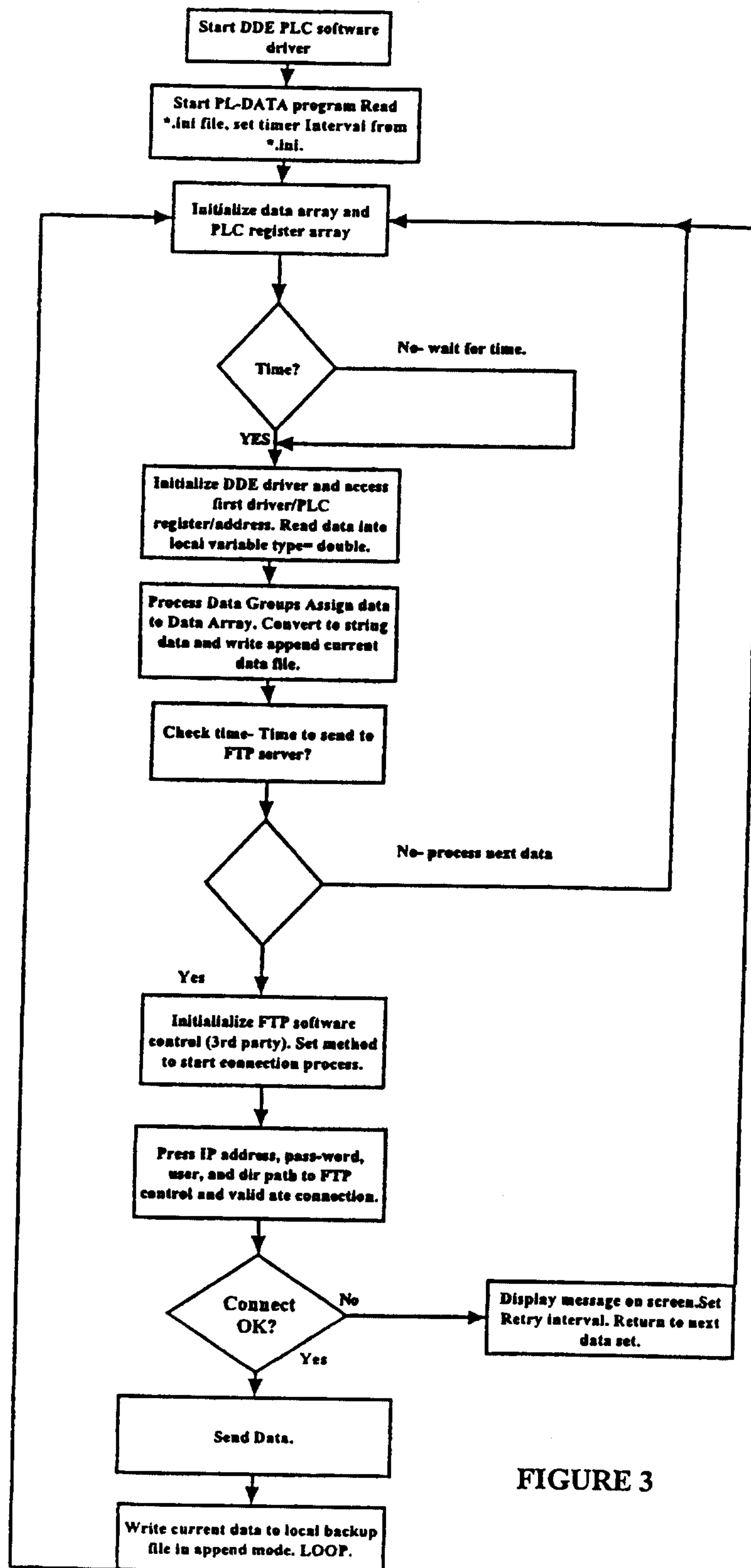


FIGURE 3

PI-Web- Data Analysis & Report Generator

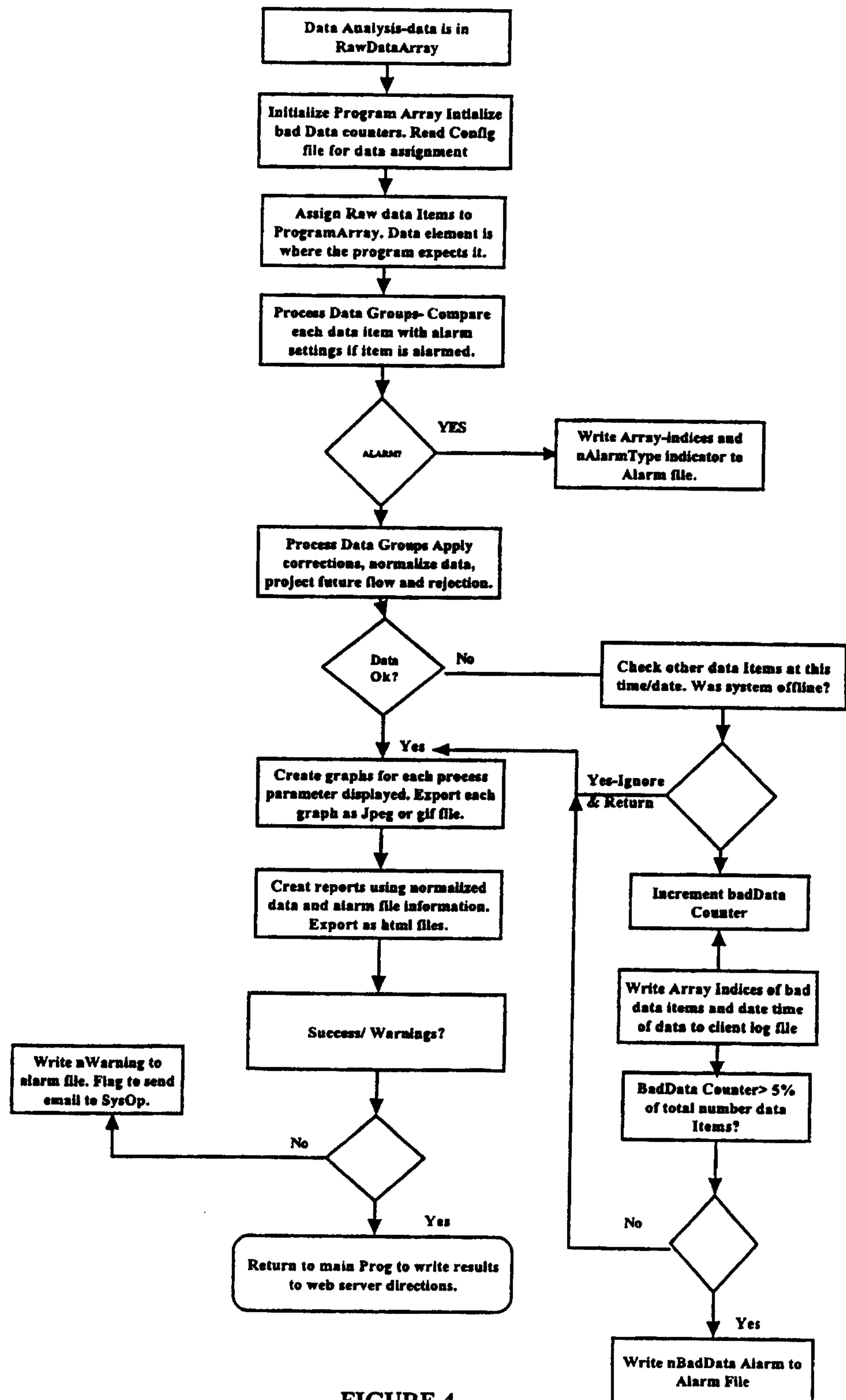


FIGURE 4

PerLorica Web and Data Flow

