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(54) **DATA LOGGING TO A DATABASE**

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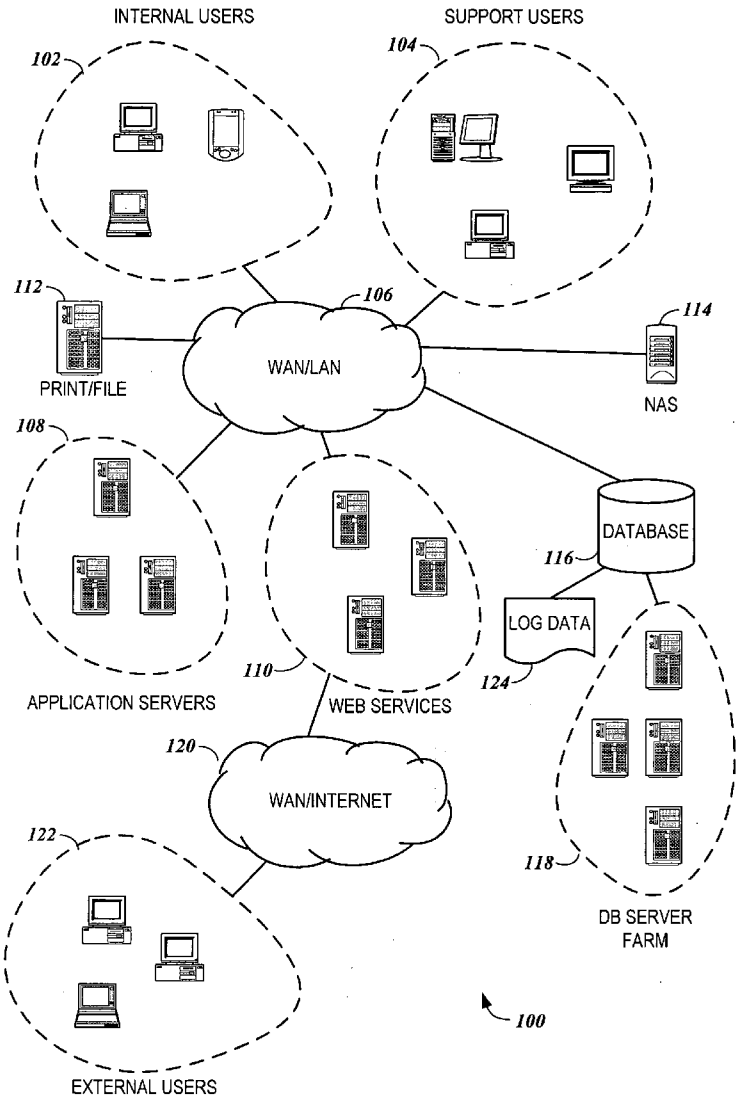
(57) **ABSTRACT**

Logging data to a database involves gathering log data from one or more applications executing on a first data-processing arrangement. The log data is gathered via a data-gathering utility executing on a first data-processing arrangement. The log data is sent via a network to a Web services interface of a log server. The log data is stored in a database accessible by the log server. The status of the first data processing arrangement is determined based on the log data stored in the database.



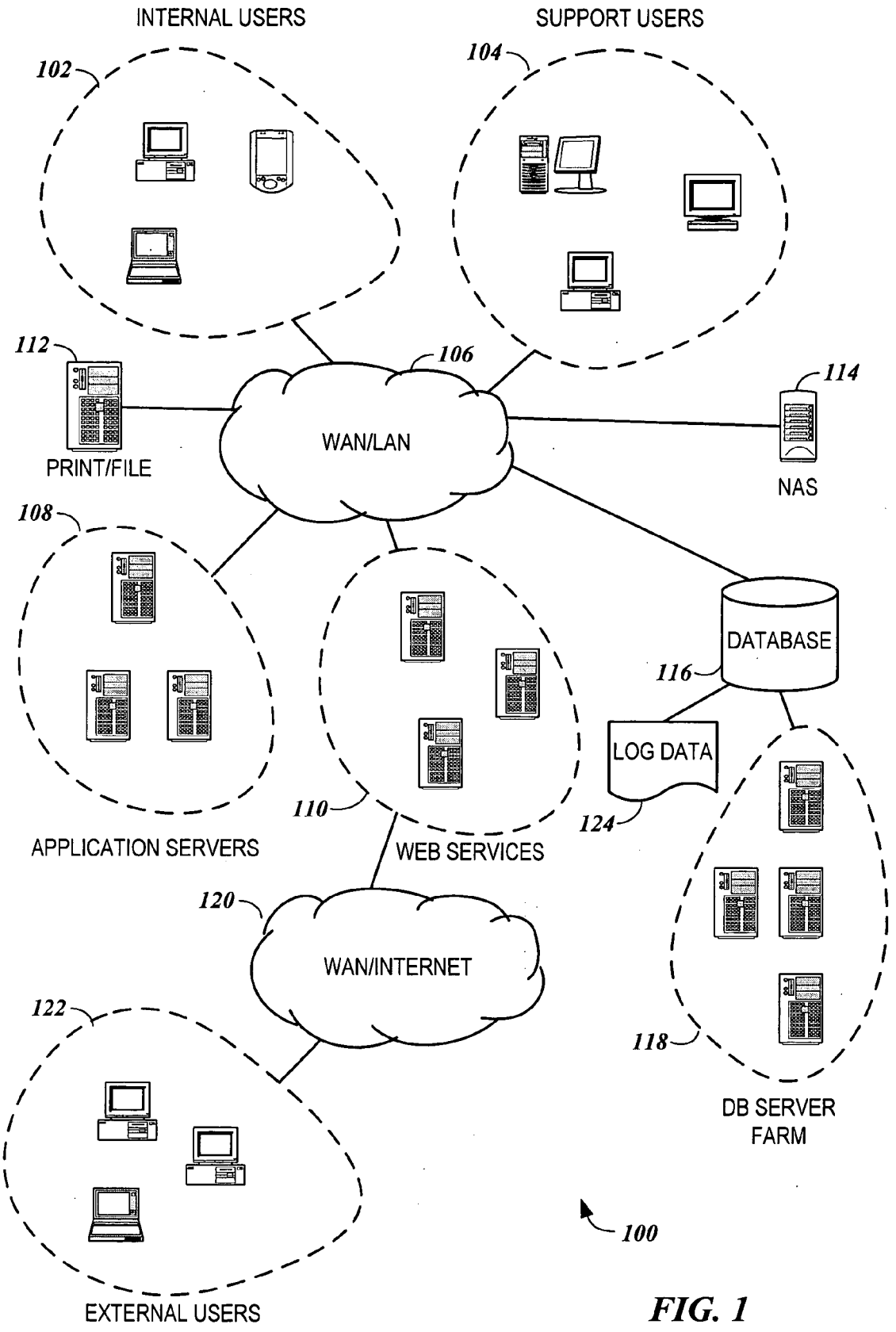

INTERNAL USERS
102
SUPPORT USERS
104
112
PRINT/FILE
106
WAN/LAN
114
NAS
108
APPLICATION SERVERS
110
WEB SERVICES
DATABASE
116
LOG DATA
124
120
WAN/INTERNET
122
EXTERNAL USERS
118
DB SERVER FARM
100

FIG. 1

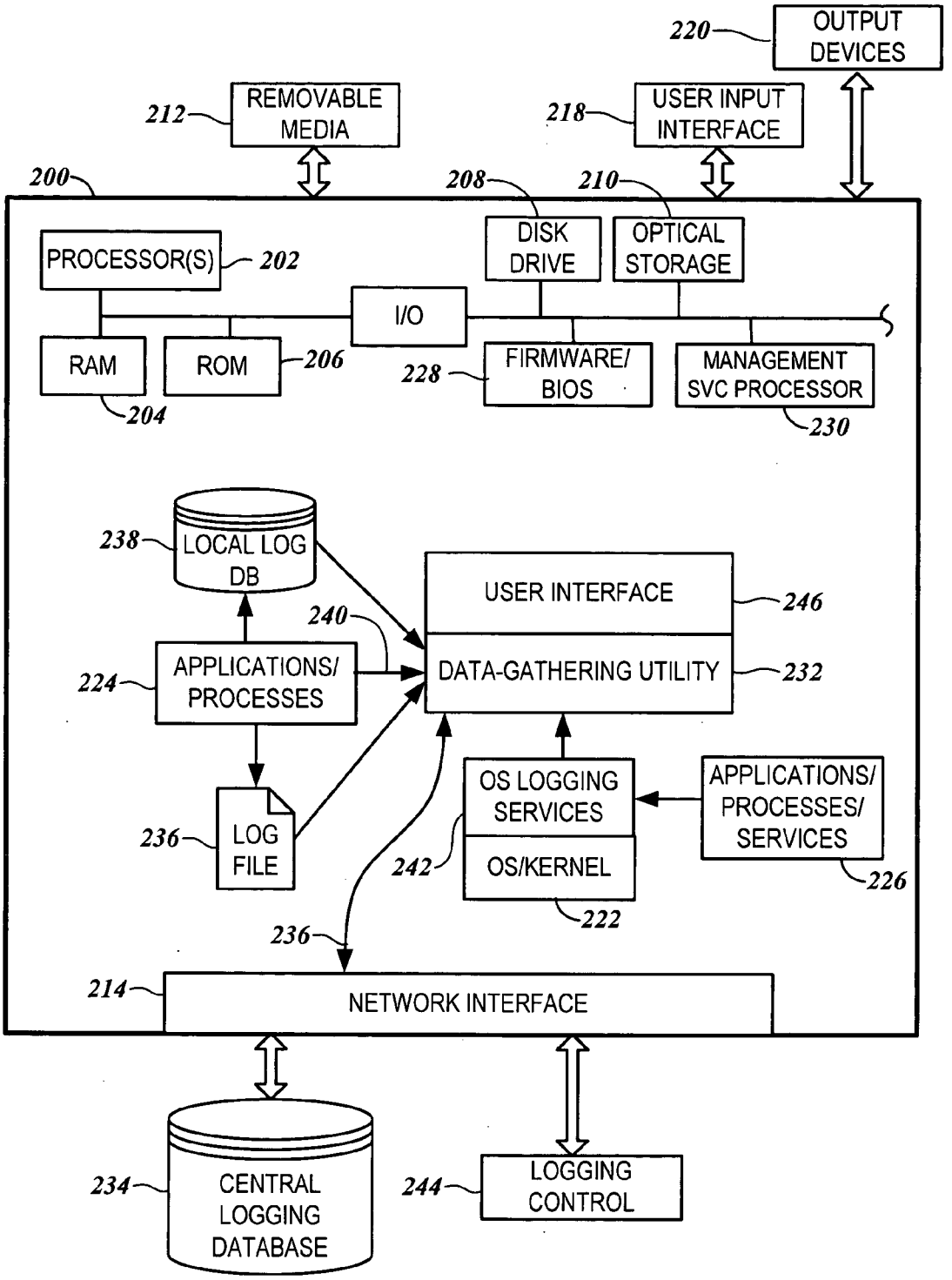

220
OUTPUT DEVICES
212
REMOVABLE MEDIA
218
USER INPUT INTERFACE
200
208
210
DISK DRIVE
OPTICAL STORAGE
PROCESSOR(S)
202
I/O
RAM
ROM
206
228
FIRMWARE/ BIOS
MANAGEMENT SVC PROCESSOR
204
230
238
LOCAL LOG DB
USER INTERFACE
246
240
APPLICATIONS/ PROCESSES
224
DATA-GATHERING UTILITY
232
OS LOGGING SERVICES
APPLICATIONS/ PROCESSES/ SERVICES
236
LOG FILE
242
OS/KERNEL
226
222
236
214
NETWORK INTERFACE
234
CENTRAL LOGGING DATABASE
244
LOGGING CONTROL

FIG. 2

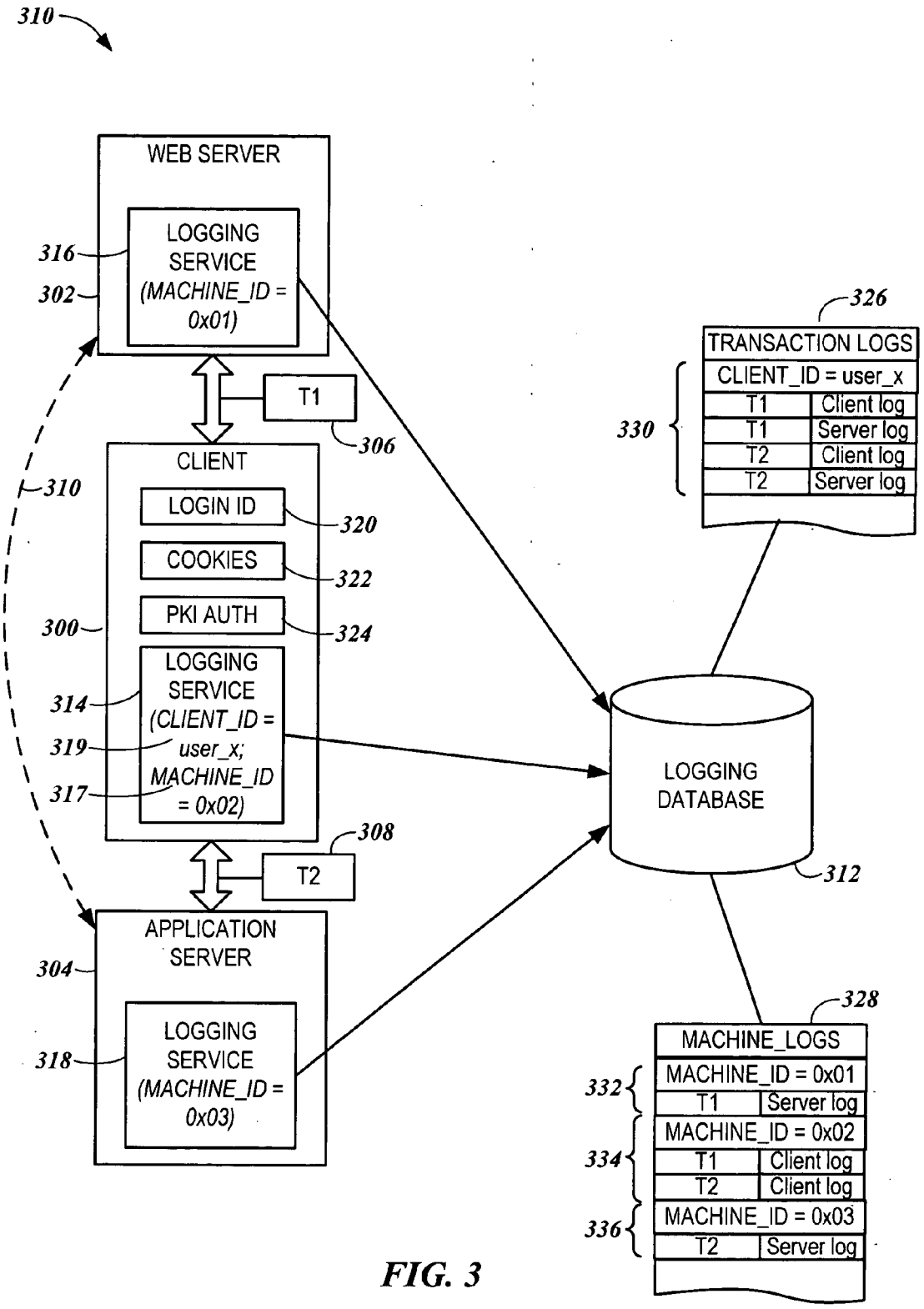

310
WEB SERVER
LOGGING SERVICE (MACHINE_ID = 0x01)
316
302
T1
306
CLIENT
310
LOGIN ID
320
COOKIES
322
PKI AUTH
324
300
LOGGING SERVICE (CLIENT_ID = user_x; MACHINE_ID = 0x02)
314
319
317
308
T2
APPLICATION SERVER
304
LOGGING SERVICE (MACHINE_ID = 0x03)
318
326
TRANSACTION LOGS
CLIENT_ID = user_x
T1 Client log
T1 Server log
T2 Client log
T2 Server log
330
LOGGING DATABASE
312
328
MACHINE_LOGS
MACHINE_ID = 0x01
T1 Server log
MACHINE_ID = 0x02
T1 Client log
T2 Client log
MACHINE_ID = 0x03
T2 Server log
332
334
336

FIG. 3

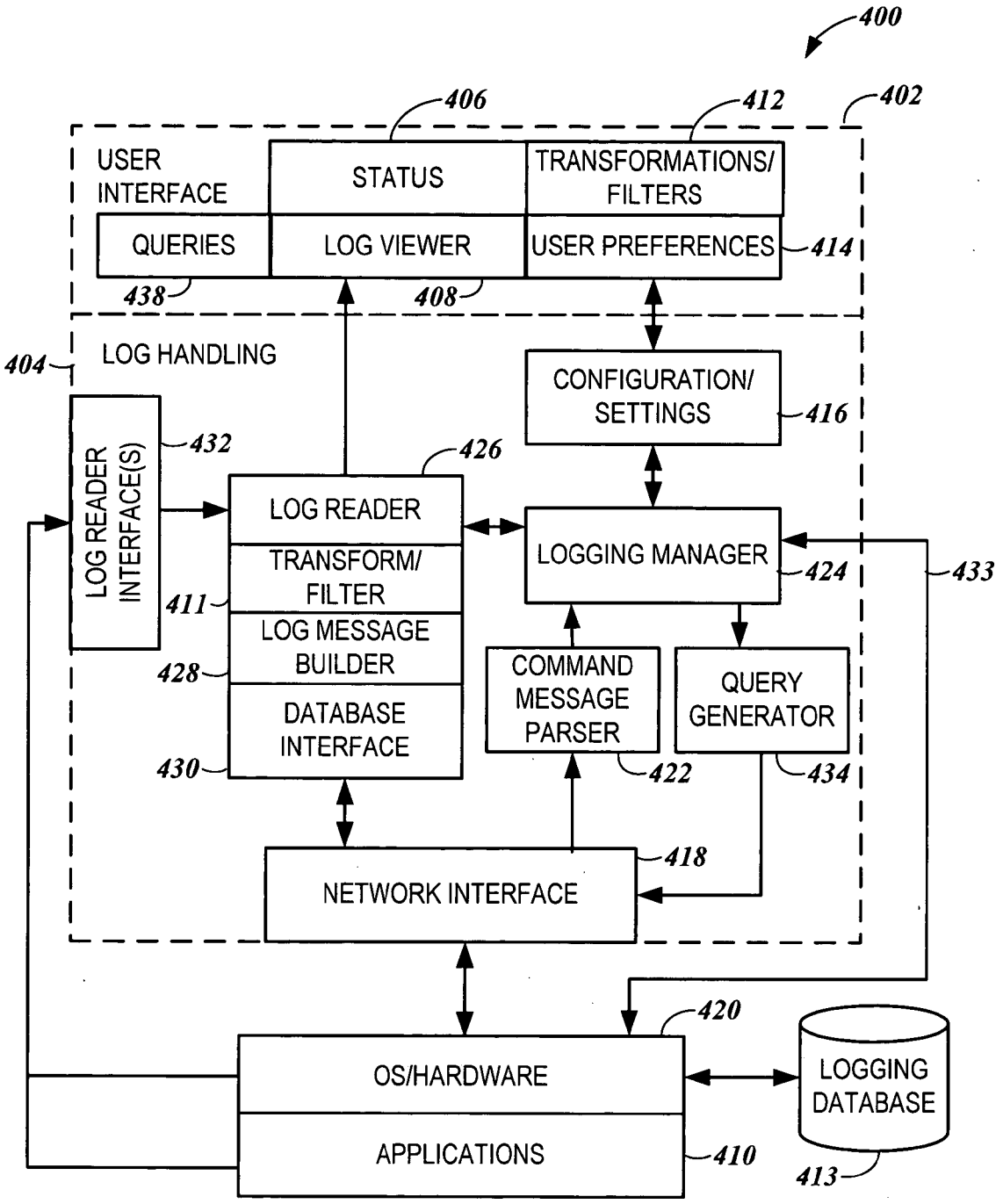

400
406
412
402
USER INTERFACE
STATUS
TRANSFORMATIONS/ FILTERS
QUERIES
LOG VIEWER
USER PREFERENCES
414
438
408
LOG HANDLING
404
CONFIGURATION/ SETTINGS
416
LOG READER INTERFACE(S)
432
426
LOG READER
TRANSFORM/ FILTER
411
LOGGING MANAGER
424
433
LOG MESSAGE BUILDER
428
COMMAND MESSAGE PARSER
QUERY GENERATOR
DATABASE INTERFACE
430
422
434
418
NETWORK INTERFACE
420
OS/HARDWARE
LOGGING DATABASE
APPLICATIONS
410
413

FIG. 4

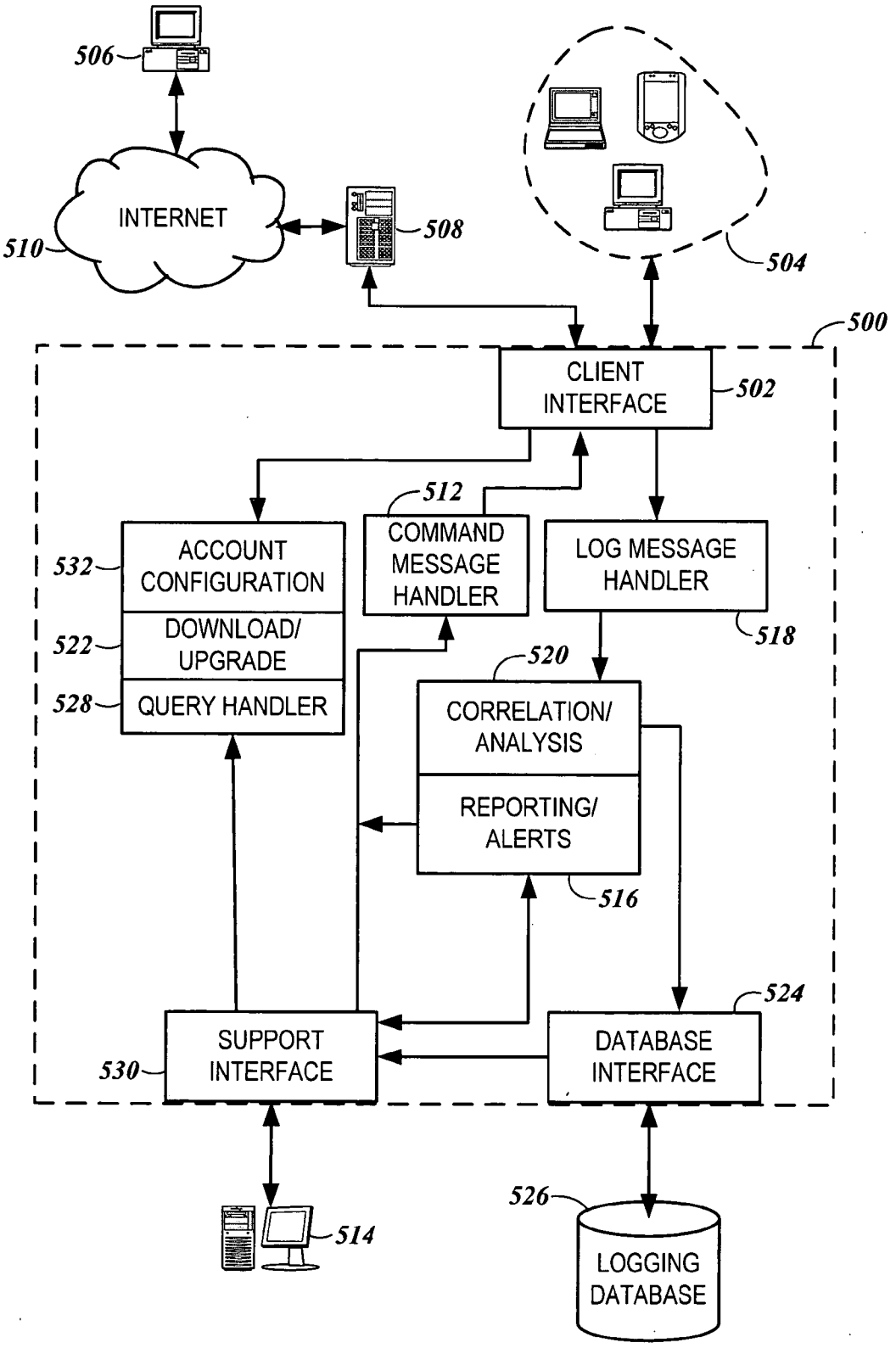

506
INTERNET
510
508
504
500
CLIENT INTERFACE
502
512
COMMAND MESSAGE HANDLER
LOG MESSAGE HANDLER
518
532
ACCOUNT CONFIGURATION
522
DOWNLOAD/ UPGRADE
528
QUERY HANDLER
520
CORRELATION/ ANALYSIS
REPORTING/ ALERTS
516
524
SUPPORT INTERFACE
530
DATABASE INTERFACE
514
526
LOGGING DATABASE

FIG. 5

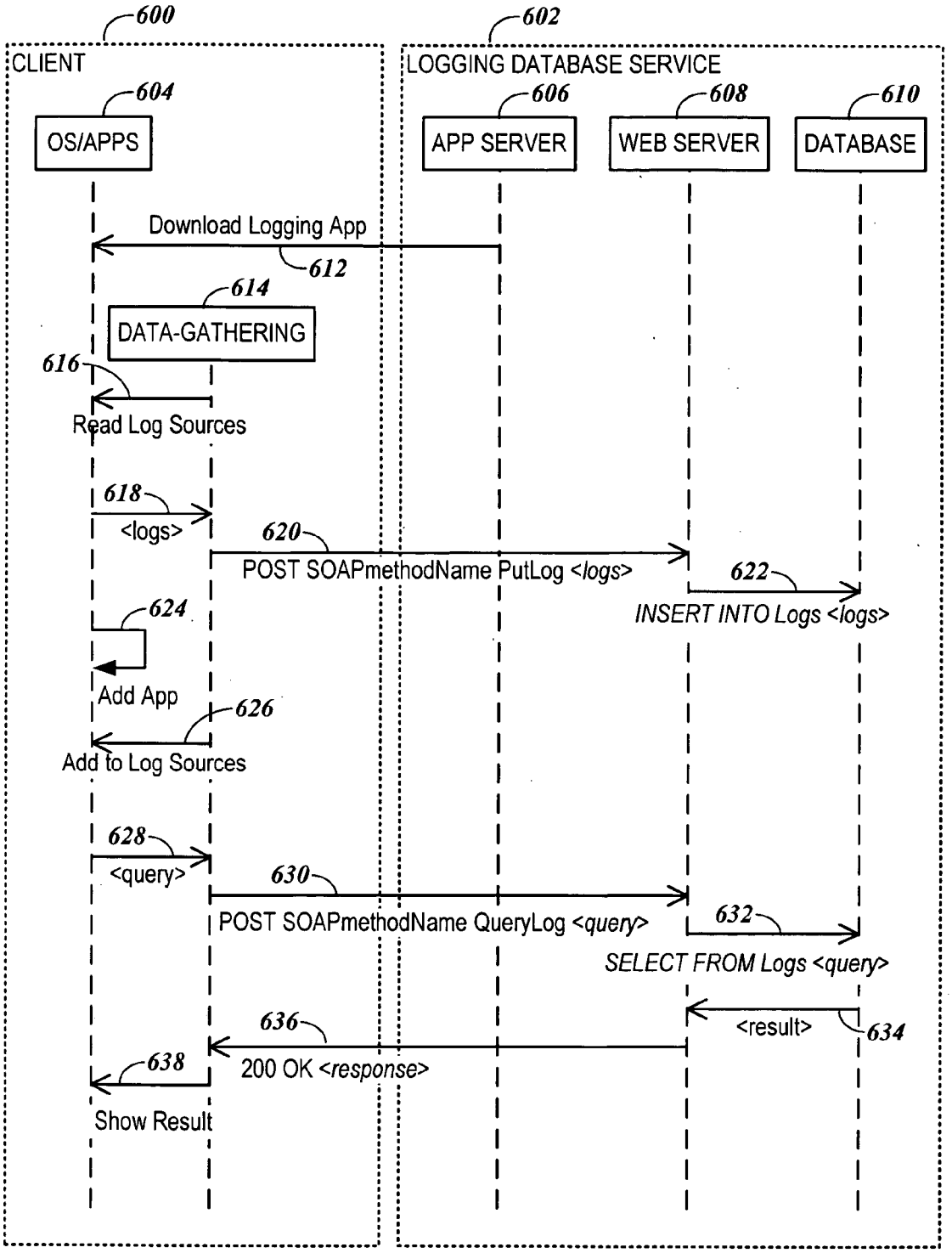

600
CLIENT
602
LOGGING DATABASE SERVICE
604
OS/APPS
606
APP SERVER
608
WEB SERVER
610
DATABASE
Download Logging App
612
614
DATA-GATHERING
616
Read Log Sources
618
<logs>
620
POST SOAPmethodName PutLog <logs>
622
INSERT INTO Logs <logs>
624
Add App
626
Add to Log Sources
628
<query>
630
POST SOAPmethodName QueryLog <query>
632
SELECT FROM Logs <query>
<result>
634
636
200 OK <response>
638
Show Result

FIG. 6

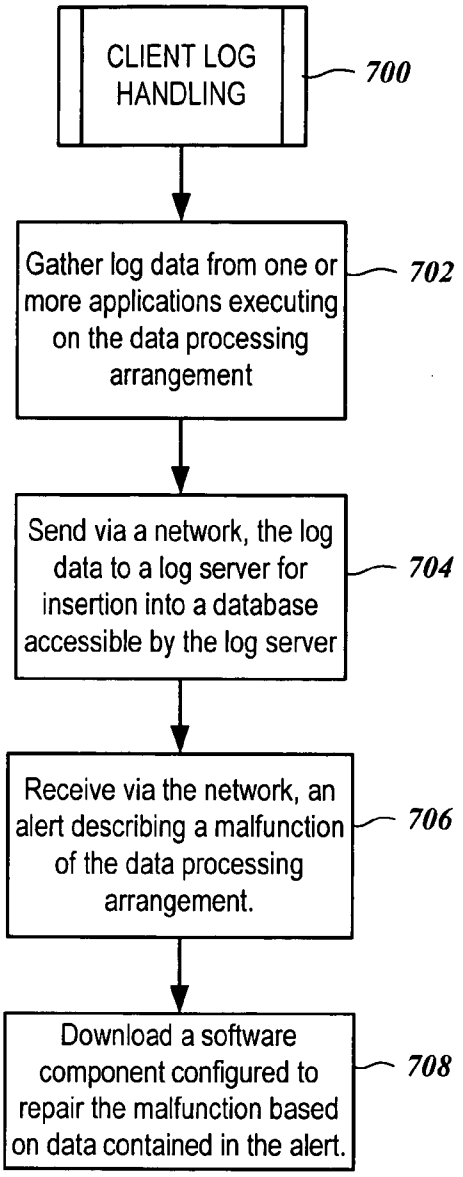

CLIENT LOG HANDLING
700
Gather log data from one or more applications executing on the data processing arrangement
702
Send via a network, the log data to a log server for insertion into a database accessible by the log server
704
Receive via the network, an alert describing a malfunction of the data processing arrangement.
706
Download a software component configured to repair the malfunction based on data contained in the alert.
708

FIG. 7

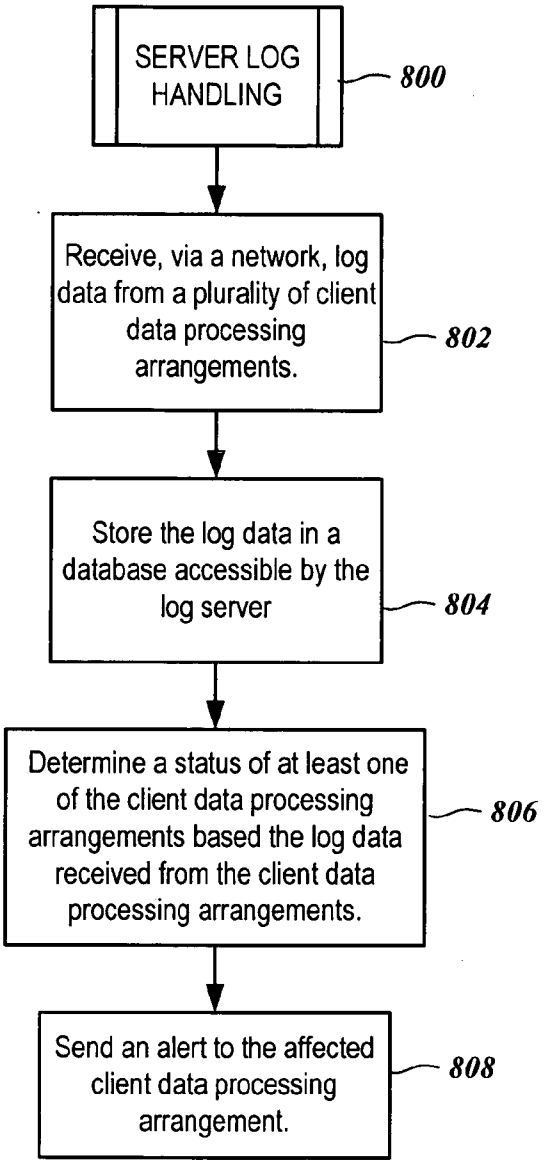

SERVER LOG HANDLING
800
Receive, via a network, log data from a plurality of client data processing arrangements.
802
Store the log data in a database accessible by the log server
804
Determine a status of at least one of the client data processing arrangements based the log data received from the client data processing arrangements.
806
Send an alert to the affected client data processing arrangement.
808

FIG. 8

DATA LOGGING TO A DATABASE

FIELD OF THE INVENTION

[0001] The present disclosure relates to data processing, and more particularly to handling log data of data processing arrangements.

BACKGROUND

[0002] Computers and networks have become commonplace in all types of enterprises, including manufacturing, services, government, and academia. Computers play important roles in these organizations. In particular, the use of computing networking has provided significant productivity gains over the last decade. In many cases, the networks have become as important as the computers themselves. Computer networks can be used by all parts of an organization to quickly and easily share data. Data sharing allows managers to know what is going on within the organization and to quickly react to problems and changes.

[0003] Networks can range in size from two machines on a home network to global scale networks such as the Internet. The smaller networks are often referred to as local area networks (LANs). A LAN can be used to share computing resources such as files and printers. In some arrangements, common computing resources are shared in a client/server arrangement. The clients are typically stand-alone computers that access a server. The servers are centralized computers that provide particular services to clients. Other paradigms for computer usage exist, such as peer-to-peer, terminal/server and thin-client/server. However, the implementation of Internet-like services in enterprises has made the client/server model dominant in many business infrastructures.

[0004] In a large enterprise, the services provided by servers and other entities may be quite complex. Besides the standard email, file sharing, print sharing and Web services associated with the client-server model, large enterprises may have custom applications. These applications can be used for Customer Relationship Management (CRM), human resources, engineering, inventory, materials acquisition, finance, etc. These applications often leverage the power of networks by utilizing distributed computing, network accessible databases, Web services, and other network technologies to perform specialized functions.

[0005] Deploying and maintaining specialized applications in a large enterprise can be difficult. Such applications can have many users distributed around the globe. Even when all the users are in the same building, the analysis of performance data and error logs sometimes requires physically accessing the client machines to look at the data. This quickly becomes unworkable when maintaining a large number of machines. Therefore a better way of managing log data in a distributed computing environment is desirable.

SUMMARY

[0006] Logging data to a database involves gathering log data from one or more applications executing on a first data-processing arrangement. The log data is gathered via a data-gathering utility executing on a first data-processing arrangement. The log data is sent via a network to a Web services interface of a log server. The log data is stored in a database accessible by the log server. The status of the first data processing arrangement is determined based on the log data stored in the database.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] **FIG. 1** illustrates a system in which data logging according to embodiments of the present invention may be employed;

[0008] **FIG. 2** illustrates a data processing arrangement with a data-gathering utility according to embodiments of the present invention;

[0009] **FIG. 3** illustrates logging data associated with distributed transactions according to embodiments of the present invention;

[0010] **FIG. 4** illustrates a component diagram of a data-gathering utility according to embodiments of the present invention;

[0011] **FIG. 5** illustrates a logging database server arrangement according to embodiments of the present invention;

[0012] **FIG. 6** illustrates a sequence of data exchanges in a logging system according to embodiments of the present invention;

[0013] **FIG. 7** is a flowchart illustrating client logging operations according to embodiments of the present invention; and

[0014] **FIG. 8** is a flowchart illustrating server logging operations according to embodiments of the present invention.

DETAILED DESCRIPTION

[0015] In the following description of various embodiments, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration various example manners by which the invention may be practiced. It is to be understood that other embodiments may be utilized, as structural and operational changes may be made without departing from the scope of the present invention.

[0016] In general, the present disclosure relates to collecting, collating and providing analysis tools for computer debug data. In particular, a system is disclosed for centrally collecting log data in a distributed computing environment. A distributed computing environment generally includes at least a plurality of client machines independently running processes that generate logging data. The client machines may communicate with one or more server machines via a network. The client machines may also communicate with each other, either as client-server or peer-to-peer.

[0017] In reference now to **FIG. 1**, a system **100** is illustrated that utilizes centralized logging according to embodiments of the present invention. The system **100** is generally utilized by an enterprise for all manner of computing tasks. The system **100** includes internal user computers **102** and support user computers **104**. The user computers **102**, **104** are typically networked client machines, although some users **102**, **104** may also have access to servers via directly connected terminals or similar devices. The user computers **102**, **104** may include any manner of

data processing device, including desktops machine, portable computers, personal digital assistants (PDAs), cellular phones, etc.

[0018] The internal user computers **102** typically run end-user applications. These applications often have a user interface (UI) configured to allow people to input data into the computer and receive output. For example, a human resource time tracking system allows workers to enter hours worked for different projects using a keyboard and mouse. The time and project data entered may be viewable by the user and others. The internal user computers **102** may be used for any type of end-user application, including finance, human resources, engineering, marketing, sales, inventory, materials tracking, content creation, data entry, etc.

[0019] The support user computers **104** may run applications that are similar to those run on the internal user computers **102**. However, the support user computers **104** may also include support applications. The support applications may include network monitoring tools, help ticket reporting, technical support databases, debuggers, remote access applications (e.g., login terminals), etc.

[0020] The user and support computers **102**, **104** are coupled via a network **106**. This network **106** may include any combination of LAN and Wide Area Network (WAN) elements known in the art. The user and support computers **102**, **104** may exchange data directly (e.g., peer-to-peer) via the network **106**. The computers **102**, **104** may also use the network **106** to access servers, such as the application servers **108**, Web services servers **110**, print/file servers **112**, Network Attached Storage (NAS) **114**, etc. In general, servers may include any commonly accessible data processing elements that store and manage data. The data may be restricted to select users or may be made available to all users of the system **100**.

[0021] A database **116** may also be commonly accessible to clients and servers on the network **106**. The database **116** is typically a specialized data storage arrangement for storing and querying large amounts of data quickly. The database **116** often stores data in the form of tables. In a particular type of database known as a relational database, associations may be defined between the tables that allow sophisticated and flexible searching of data. The database **116** may be implemented on a single machine. In other arrangement, the database **116** may be distributed across multiple machines, such as on a server farm **118**. Often, the database **116** includes a generic interface that hides the programmatic and physical implementation of the database **116** from users. For example, the database may support standardized Structured Query Language (SQL) queries.

[0022] The system **100** can provide many advantages to an organization. Tasks that require data inputs from various parts of the organization can be entered into computer systems (e.g., internal user computers **102**) and stored on commonly accessible servers. By doing this, the managers of the organization can obtain near-real-time data that shows status of many activities in the organization. These activities need not be confined to a single building or campus. The ubiquity of wide area networks such as the Internet **120** allow this data exchange to occur on national and global scales. In sophisticated enterprise systems, external users **122** can seamlessly connect to the organization wherever there is Internet **120** availability.

[0023] Regardless of the advantages, distributing tasks among users of the system **100** can give rise to problems. These problems often relate to tracking technical problems on transactions that occur between distributed computational resources of the system **100**. For example, a transaction may involve computations that occur on both internal user computers **102** and Web services servers **110**. If the internal user computers **102** are using standalone PCs, the log data is typically stored on the local machine in a file or database. Likewise, the log data of the Web services servers **110** will be stored locally on those servers **110**. It can be difficult to match up log data for a single transaction that occurred partially on a user computer **102** and a server **110**. This may be exacerbated when the different computers use different operating systems and different methods of creating and storing log data.

[0024] In order to better manage log data among elements of the system **100**, a database **116** may be set up as a centralized repository of log data **124**. Computing elements of the system may generate, modify and send log data **124** to this commonly accessible database **116**. Elements that generate log data may include internal users **102**, support users **104**, external users **122**, servers **108**, **110**, **112**, **114**, etc. The log data may originate from an application, process, daemon, service, module, operating system, or any other executable code running on any device in the system **100**.

[0025] It will be appreciated that a wide variety of software running on different hardware and operating systems will incorporate a wide variety of logging techniques. These logging techniques may include sending logs to files, memory, network connections, OS messaging, Inter-Process Communications (IPC), and the like. Therefore, a logging system that is useful across the entire enterprise should be able to take these various logging methods into account.

[0026] Referring now to **FIG. 2**, a data processing arrangement **200** is shown using a logging utility according to embodiments of the present invention. The data processing arrangement **200** may be representative of any computational device used in the enterprise, including desktop computers, servers, portables, PDAs, embedded devices, etc. The data processing arrangement **200** includes one or more processors **202** coupled to various forms of memory. The processor(s) **202** are arranged to execute instructions stored on or provided by such memory. Memory accessible by the processor(s) may include random access memory (RAM) **204**, read-only memory (ROM) **206**, disk drives **208**, optical storage **210** (e.g., CD-ROM, DVD), etc. The processor(s) **202** may also access data via memory available on removable media **212**, such as floppy disks, Zip disks, flash memory, CD-ROM/R/RW, DVD, etc. The processor(s) **202** may also execute instructions received via a network interface **214**. The network interface **214** may be data coupled to any data transfer network such as a LAN, WAN or global area network (GAN) such as the Internet.

[0027] The data processing arrangement **200** may include and/or be coupled to a user input interface **218** and an output device **220** (e.g., a monitor) for interacting with users. The data processing arrangement **200** includes software that may be provided in the form of instructions executable by the processor(s) **202**. Generally, the software includes an operating system (OS) **222** for the control and management of hardware and basic system operations, as well as running

processes/applications **224**, **226**. The OS **222** may include any type of kernel (e.g., monolithic kernel, microkernel, exokernel, etc.) and user interface software such as a shell and/or graphical user interface (GUI).

[**0028**] The data processing arrangement **200** includes firmware **228** used by the OS/kernel **222** for accessing hardware and processor functionality during boot time and run time. The firmware **228** may include a Basic Input-Output System (BIOS) for providing basic hardware access during system boot. The data processing arrangement **200** may also include independently running hardware/processors such as a management service processor **230**. A management service processor **230** may be utilized in server farms, clusters, and other remotely serviced and managed systems. The management service processor **230** runs independently of the processor(s) **202** and OS **222** of the data processing arrangement **200**. The service processor **230** may be remotely accessed for checking status, logs, and providing system updates, including revisions to firmware/BIOS **228**.

[**0029**] It will be appreciated that the example data processing arrangement **200** need not contain all of the software and hardware components listed for purposes of performing centralized logging. However, the arrangement **200** may at least include a data-gathering utility **232** for receiving, formatting, and sending log data to a centralized logging database **234**. The data-gathering utility **232** is typically configured as a locally running process that gathers logs and other useful maintenance data from various parts of the data processing arrangement **200**.

[**0030**] The data-gathering utility **232** may collect logging data from any source on the data processing arrangement **200**. Those sources may include applications, processes, services, operating systems, firmware, hardware, etc. For example, the data-gathering utility **232** may collect data from user applications **224**. This data collection may occur by examining local log files **236** or other persistent storage such as a local database **238**. The data-gathering utility **232** may collect data from these persistent sources **236**, **238** by any mechanism known in the art, including polling, redirection of output, monitoring write accesses, etc.

[**0031**] The data-gathering utility **232** may also collect log data from the application **224** directly, as represented by path **240**. This direct collection may be accomplished through mechanism such as pipes, messages, IPC, and the like. The OS **222** may also provide a standardized way for applications/process/services **226** to report logging data. This is represented by the logging services module **242**. The logging services module **242** may be accessed via a standard Application Program Interface (API) provided for use with the OS **222**. The data-gathering utility **232** may also access this API to receive log data from the logging services module **242**.

[**0032**] Another function of the data-gathering utility **232** is to send data to the central logging database **234**. The database **234** may be accessed via a network as indicated by path **236** to the network interface **236**. Other data interfaces may also be used to send log data to the database **234**. For example, data busses such as serial, USB, IEEE **1394**, direct wireless transmissions, and the like, may be used to communicate log data to the database **234**.

[**0033**] In addition to sending data, the data-gathering utility **232** may also receive data via the network interface **236** and other external data interfaces. For example, a logging controller **244** may be used to externally control aspects of the data-gathering utility **232**. The logging controller **244** may control behavior of the logging application **232** such as debug log levels, enabling logging, system parameters, security settings, etc. The behaviors of the data-gathering utility **232** may also be controlled locally via a user interface (UI) **246**. In addition, the user interface **246** may control other local settings such as user identity, transformation/filtering of logs, UI preferences, performance settings, etc.

[**0034**] The data-gathering utility **232** may be utilized on any computing arrangement that generates log data. The data-gathering utility **232** may be configured and compiled for particular computers and operating systems. This OS-specific code may include both binary code (e.g., compiled C/C++ code) and interpreted code (e.g., Visual Basic™). The data-gathering utility **232** may also utilize OS-independent code, such as a Java™ applications.

[**0035**] The data-gathering utility **232** generally includes a uniform interface for communicating with the database **234**. The uniform logging interface provides the ability to collect a uniform set of logs from multiple hosts without requiring details of the underlying database architecture. This uniformity of log data is useful when disparate hosts each create logs that relate to a single transaction. An example of a multi-host transaction according to embodiments of the present invention is shown in **FIG. 3**. Three network elements are shown in **FIG. 3**: a client **300**, a Web server **302**, and an application server **304**.

[**0036**] The client **300** is often the initiator of transactions, such as in response to user actions/inputs. Network transactions may result from these inputs, and the transactions may involve communications between a number of computing elements. In the illustrated example, two transactions **306**, **308** are illustrated. Transaction **306** involves the client **300** accessing the Web server **302**. This transaction **306** may occur, for example, in response to a Hypertext Transfer Protocol (HTTP) "GET" method call. The other transaction **308** is between the client **300** and the application server **304**. This transaction **308** may be, for example, a Remote Procedure Call (RPC).

[**0037**] Real world transactions may involve many lines of debug logging and involve more than two machines. For example, the Web server **302** may invoke an RPC call on the application server **304** in response to a request, as represented by path **310**. In such scenarios, it is useful to gather all of the log data in a commonly accessible database **312**.

[**0038**] It will be appreciated that for the illustrated transactions **306**, **308**, log data will be generated at both the client **300** and the servers **302**, **304**. For this simple example, it will be assumed that the transactions **306**, **308** generate one line of debug at the client **300** and the affected server **302**, **304**. The actual log data is represented in **FIG. 3** by the text "Server log" or "Client log" as appropriate.

[**0039**] To gather the log data into the database **312**, the client **300**, Web server **302**, and application server **304** each include data-gathering utilities **314**, **316**, and **318**, respectively. Each of the data-gathering utilities **314**, **316**, and **318** maintain internal variables that are of use when entering data into the database. For example, a machine ID (e.g., ID **317**)

is useful to identify the physical device that generated the log. The machine ID may be, for example, an Internet Protocol (IP) address, a processor ID, a Media Access Control (MAC) address, etc. In the illustrated example, the machine ID **317** is a hexadecimal value. The client data-gathering utility **314** also maintains a client ID **319**, which is set to "user_" in this example. The client ID **319** is useful for tracking transactions initiated by the user of a client computer **300**.

[**0040**] The client ID **319** may include any user specific data that is appropriate for the target application. The client ID **319** may be formed using a login/email ID **320**, a value stored in a browser "cookie"**322**, an encryption key **324**, or any other data token known in the art. The machine ID **317** may also be used as a part of a client ID **319**.

[**0041**] The data-gathering utilities **314**, **316**, and **318** may include: identifying data along with the log data so that the log data can be identified and categorized in the database **312**. In the illustrated database **312**, the log data is shown into two tables, a transaction log table **326** and a machine log table **328**. The transaction log table **326** is indexed by client ID, and contains entries **330** for both of the illustrated transactions **306**, **308**. The machine log table **328** contains entries **332**, **334**, **336** indexed by machine ID. It will be appreciated that for purposes of keeping the database **312** compact, all the log entries would likely be placed in a single log table. The data from this single log table can be queried to produce the listings shown in the transaction log table **326** and a machine log table **328**.

[**0042**] The database **312** may contain other tables useful for analyzing debug log tables. For example, tables may be created that describe users and machines to help link logs that were generated from different computers involved in distributed transactions. In some computers, certain identity information may not be included the logging data. Some servers, for example, may not have access to the user ID **319** of the transaction initiator. However, data such as IP address of the source (e.g., the client **300**) may be included in these server logs. In that case, user and machine tables in the database **312** may be used to link a source IP address to a particular user ID.

[**0043**] As shown in **FIG. 3**, various data-gathering utilities **314**, **316**, **318** are utilized to collect log data and send that data to the database **312**. The data-gathering utilities **314**, **316**, **318** may include any form of binary instructions, interpreted code, scripts, hardware, and firmware. The components of an example data-gathering utility **400** according to embodiments of the present invention are shown in **FIG. 4**. The data-gathering utility **400** is divided into two functional components, a user interface **402** and a log handler **404**. The log handler **404** may be configured to gather, modify, and send logging data. The user interface **402** allows a user to configure and control the behavior of the utility **400**, as well as to view data used by the utility **400**, including the logs themselves.

[**0044**] The user interface **402** may include a status component **406** that provides the user with status data. The status data may include indications as to whether the application **400** is currently operating, number of logs collected/sent, existence of errors, etc. The user interface **402** may also include a log viewer component **408** that provides the user with a real-time or historical playback of logging data. The viewer component **408** may present, for example, a list of log messages along with associated meta-data such as time stamps, originating application, etc.

[**0045**] Many times, the log messages are in a format that is specified by a particular application **410**. If the application **410** is written by a third party, the data-gathering utility **400** may have no control over the format of those logs as they are received. Therefore, the data-gathering utility **400** may include a transformation component **411** that transforms and formats log messages. The transformations may be defined by a transformation/filter component **412** of the user interface **402**.

[**0046**] Transformations applied by the transformation component **411** may make the logs easier to read and/or make the messages more compliant with what is expected for use in a logging database **413**. For example, the application **410** may include text or binary numerical codes as part of debug output. The numerical codes may map to one or more error strings. The transformation component **411** may be configured to parse those numerical values, look up the error strings, and replace the numerical values with the strings. The transformation component **411** may also be used to transform cryptic or misleading text messages. For example, the transformer **411** may be configured to automatically change the text "ERROR ON DISC LOAD DRIVE" to "CD ROM DRIVE NOT WORKING."

[**0047**] The transformation component **411** may also be used to filter logging data. For example, for some situations, the user may want to report only the error messages of the application **410**, and ignore status messages. If the application **410** cannot limit the debug output in this way, the transformation component **411** may be configured to detect and discard all non-error messages. The transformation component **411** may perform this function by string searching using regular expressions or other search methods known in the art.

[**0048**] The transformer component **411** may get its transform and filter settings from any combination of a local source (e.g., the transform/filter component **412** and/or a configuration file) and a remote source (e.g., the logging database **413**). The user may manage other application settings via a user preferences component **414** of the user interface **402**. The user preferences component **414** may be used to set any other preferences of the user interface **402** and the log handler **404**. These preferences may include GUI settings, applications selected for log reporting, performance parameters (e.g., use of compression, binary messages), destination databases, authentication, security, network parameters, etc.

[**0049**] The user preferences component **414** provides a user accessible front end to manage configuration settings. The storage and retrieval of those settings is handled by a configuration/settings component **416** of the log handler **404**. The configuration/settings component **416** interfaces with persistent storage (e.g., registry, configuration file) to maintain settings between sessions. The configuration settings component **416** may also utilize a network interface **418** for retrieving remotely stored settings and/or receiving dynamic commands via a network control entity. For example, the user settings may be accessed from a Web server using HTTP commands via the network interface **418**, so that certain settings remain constant no matter what physical machine the user is on.

[0050] The network interface **418** in this example is a software interface designed to transparently access network hardware via the OS **420**. The network interface **418** may provide a generic interface that allows network data access using multiple network protocols (e.g., HTTP, SOAP, RPC). The use of a generic network interface **418** allows the components of the application **400** to be designed independently of the underlying networking technologies used in the enterprise.

[0051] It will be appreciated that in many cases a system maintainer may want to remotely switch logging facilities on and off, or set a particular debug level to restrict the amount of data received at the logging database **413**. This may be accomplished by sending command messages to the data-gathering utility **400** via a network. The data-gathering utility **400** may include a command message parser **422** to handle command messages received via the network interface **418**. These messages can be interpreted at the parser **422** and be passed along to a logging manager **424**. One function of the logging manager **424** is to handle control logic for the application **400**.

[0052] The parser **422** may also be configured to deal with messages and alerts sent via a technical support service. The messages and alerts may be directed to a component of the user interface **402** (e.g., the status component **406**) to alert the user to important information such as system malfunctions. Alerts received at the data-gathering utility **400** may contain data that assists the user in solving a particular problem. For example, the alerts may contain a hyperlink to an application server where the user may download a software component (e.g., patch or program) that solves the problem. Alternatively, the alert may contain executable code (e.g., script or binary instructions) that may be passed to the logging manager **424** for further handling. Typically, the logging manager **424** would pass this executable code to the OS **420** for execution/processing. The execution of such code would likely be predicated upon user acceptance and involve other checks, such as verifying authentication certificates and code integrity (e.g., MD5 digest). These checks may be performed by the OS **420** and/or the logging application manager **424**.

[0053] The logging manager **424** generally handles the control logic for operation of the data-gathering utility **400**. The logging manager **424** may be configured to receive commands from both the user via the user interface **402** and from remote sources via the network interface **418** and parser **422**. These commands can be used to set states of the data-gathering utility **400**. The states of the data-gathering utility **400** may include persistent states (e.g., logging turned on or off) that are maintained by the configuration settings component **416**. Dynamic states (e.g., current activity level) of the data-gathering utility **400** may also be tracked by such components as the logging manager **424** and the user interface **402**.

[0054] In addition to the previously discussed transformer/filter component **411**, the log handler **404** may include other components for processing log data received from the application **410**. These components include a log reader **426**, a log message builder **428**, a database interface **430**, and log reader interface **432**. The log reader interface **432** may include one or more specific interfaces used to receive logs generated by applications **410**, the OS **420**, and any other system component capable of generating logging data. The log reader interface **432** may contain multiple data interface instantiations to read from sources such as files, OS services, messages, IPC, etc.

[0055] The logging manager **424** may also be used to arbitrate the connections between the log reader interface **432** and the applications **410**. For example, the logging manager **424** may be configured to automatically detect the addition and/or deletion of applications **410** from the system. This detection may occur, for example, by the use of specialized registry entries maintained by the OS **420**. The log handler may check these registry entries on startup and/or by regular polling of the registry, as indicated by the path **433**. If a new application **410** is detected, the logging manager **424** may configure the log reader interface **432** to receive data from this new application **410**.

[0056] The logging manager **424** may also be configured to detect whether a previously detected application **410** is currently running. If the application **410** is not running, there is no need to activate a log reader interface **432** for that application **410**. However, the logging manager **424** may use facilities available via the OS **420** to detect when the applications **410** start, and thereby activate an appropriate log reader interface **432** to collect logs from that application **410**.

[0057] The log data received at the log reader interface **432** is passed to the log reader **426** that buffers and selects messages for further processing. The log reader **426** passes selected messages to the transformer/filter **411** that processes the messages as previously described. The transformer/filter **411** then passes the log data to the message builder **428**, which may add system data to the logs (e.g., timestamps, IDs) and create a message conforming to a standard format. The message builder **428** passes the messages to the database interface **430**, which handles the formats and states required to send the messages to the logging database **413**.

[0058] The database interface **430** may also be configured to read log data from the logging database **413**. For example, the user may desire to use the data-gathering utility **400** to query log data from this or other computers that is stored in the database **413**. The application **400** may include a query generator **434** that sends inquiries to the logging database **413**. The query responses may be received at the database interface **430** and sent to the log viewer **408**, either directly or via the log reader **426**. The query generator **434** may have an associated query UI component **438** to assist in forming the queries.

[0059] It will be appreciated that variations of the data-gathering utility **400** may be tailored to specific users. For example, for users outside the enterprise (e.g., external customers), the application **400** may be configured to track only a small set of actions, such as those actions required to access enterprise Web sites. This restricted operation may be preferable for reasons of limited bandwidth and privacy. For an external user, the logging information would be transferred from the application **400** to the logging database **413** using a secure method such as Secure Sockets Layer (SSL).

[0060] In another example, the data-gathering utility **400** may be tailored for use by support users (e.g., help desk clients). In such a configuration, the reading of local logs via the log reader interface **432** may not be required because the

maintainer is generally interested in the logs of other machines. A maintainer would typically access stored log data through the query generator **434**. The configuration of the data-gathering utility **400** used by the maintainer would likely have much broader permissions to access the database **413** and other computers than would a typical user configuration. A maintainer application may also include other components for controlling logs, such as a command generator and analysis tools.

[**0061**] The data-gathering utility **400** may also be adapted for users such as software developers. The utility could be use to transmit logs of debug output, compiler warnings/errors, etc., to the database **413** instead of writing this data locally. The data-gathering utility **400** may have custom designed interfaces **402** for various types of users from finance to technology which are configurable and log enabled. The data-gathering utility may also be enabled to transfer history or browsing usage from the Web browsers to the logging database **413**. This way, all browsing history of a user will be in a central place through which an administrator can generate reports and make use of them.

[**0062**] Generally, the log data collected by the data-gathering utility **400** is sent to a commonly accessible logging database **413**. Such a database **413** may associated with a logging database server that provides system-wide monitoring and control of data logging activities. An example of a logging database server **500** according to embodiments of the present invention is shown in **FIG. 5**. The database server **500** may be included on a single machine or distributed among multiple physical machines.

[**0063**] The database server **500** contains a client interface **502** that receives log data from a plurality of internal clients **504**. The client interface **502** may also receive log data from external clients **506**, such as via a Web server **508** coupled to the Internet **510**. The client interface **502** may also send data to internal clients **504** and external clients **506**. For example, the client interface **502** may send configuration settings from a command message handler module **512** to clients **506**, **508**.

[**0064**] The command message handler **512** is used to route command messages to logging software on client computers **506**, **508**. The commands may originate from a support user machine **514** or be automatically generated via a reporting/alerts module **516** of the database server **500**. The command message handler **512** may provide the ability to identify particular clients **506**, **508** as targets for command messages. In other scenarios, the command message handler **512** may broadcast or multicast messages to groups of machines. The command message handler **512** may also handle other bookkeeping tasks involved in sending messages, including receiving acknowledgements and reporting failures or errors in the commands. It will be appreciated that the functionality included in the command message handler **512** may also be included entirely within the support user machine **514** and similar entities.

[**0065**] Client log data received at the client interface **502** may be sent to a log message handler **518**. The log message handler **518** may perform actions such as buffering messages, checking log messages for errors, stripping headers from messages, etc. The log message handler **518** then passes messages to a correlation/analysis module **520**. The correlation/analysis module **520** may be used for data reduction (e.g., grouping redundant data), correlating messages with transaction identifiers, monitoring rate of incoming messages, identifying patterns, etc. The analysis data gathered by the correlation/analysis module **520** may be used by the reporting/alerts module **516**.

[**0066**] It will be appreciated that the correlation/analysis module **520** and reporting/alerts module **516** may be used to quickly identify and resolve system problems. For example, the reporting/alerts module **516** may be configured to detect a threshold number of logging errors that indicate a server is refusing connections. This may be used to generate an alert that is sent to a support user **514** for resolution. In another example, a recognizable pattern of logging errors may indicate that a system has misconfigured software (e.g., incompatible versions) or compromised software (e.g., infected with a virus). The correlation/analysis module **520** and reporting/alerts module **516** may be used to detect these patterns and alert a client machine (e.g., client **504**) of the problem. The alert may also provide a solution for the user, such assisting in downloading a software patch via a download/upgrade module **522** of the server **500**.

[**0067**] After passing through the correlation/analysis module **520**, the logging messages are then sent to a database interface **524** for placement in a database **526**. The database **526** may be a relational database (e.g., SQL compatible) such as Oracle, SQL Server, DB2, MYSQL, and the like. The database **526** may be XML-enabled, object-relational, object-oriented, multi-dimensional, and include any other features known in the art. The database **526** may be implemented on a single host or be distributed over multiple hosts.

[**0068**] Access to the database **526** may be provided to various clients (e.g., **504**, **514**) via a query handler **528**. For example, the query handler **528** may receive a query from a support user **514** via a support interface **530**. The query handler **528** may transform this query (e.g., from plain text to an SQL query) and send the query to the database interface **524**. The response to the query may pass through the query handler **528** or be sent directly to the requesting user **514**.

[**0069**] The database **526** may contain a wide variety of information pertaining to client users and equipment. This information may be used to form specialized queries of the database **526**. For example, a query could be used to answer a question such as "How many seconds is boot up on a HP Pavilion with Pentium 4 2.4 GHZ processor running windows?" The query handler **528** could process this query through the database interface **524** and provide a response. Such query responses could present the average of all such systems, and also break down information by major component differences such as OS versions (Windows™ 3.1, 95, Millennium, XP, 2003, etc.), amount/type of memory, video drivers, software differences, etc. These specialized reports could be processed using Online Analytical Processing (OLAP) tools.

[**0070**] The database **526** and correlation/analysis module **520** could also be used for pattern analysis and recognition on stored data. For example, patterns of stored data could be analyzed to answer such performance optimization questions as "What is the difference between systems that boot in 30 seconds versus those that take longer?" or "What is the difference in the input error rate between a Wacom tablet and

a Microsoft Natural Keyboard?" Similarly, the stored data could be analyzed to provide troubleshooting and problem resolutions. For example, user could compare system configuration with those in the database **526**. If other users are located that had similar problems, the solution those other users used could be determined.

[**0071**] The database server **500** and related equipment can serve as a repository and analysis center for enterprise-wide logging data. The database server **500** may also provide other commonly accessible functions related to logging. For example, an account configuration module **532** may be accessed to read, save, and modify user account information. The account configuration module **532** may be useful in applying system wide configuration settings, such as setting default log levels.

[**0072**] The client interface **502**, database interface **524**, and support interface **530** may use any combinations of new and existing data transfer protocols. For example, the client and support interfaces **502**, **524**, may be Web services based. Web service interfaces may support, for example, Simple Object Access Protocol (SOAP) calls over HTTP. The database interface **524** may be native to the database **526**, or may include middleware components that provide generic database access methods that are independent of a particular database **526**.

[**0073**] The functions of the database server **500** may be provided on a single computing arrangement or be distributed among various server components. An example of logging transactions that occur between multiple client and server components according the present invention is shown in **FIG. 6**. In **FIG. 6**, a sequence diagram shows transactions between a client **600** and a logging service **602**. The client **600** at least includes an OS and applications **604**. The logging service **602** includes an application server **606**, a Web server **608** and a database **610**. These logging service components **606**, **608**, **610** may be distributed across different physical machines or be hosted on a single machine.

[**0074**] Initially, the client **600** downloads (**612**) the data-gathering utility **614** from the application server **606**. Once the data-gathering utility **614** is started, it will read (**616**) the available log sources from a system registry or other source on the client **600**. Subsequently, the data-gathering utility **614** can receive logs (**618**) from the OS and application **604**. These logs can be sent (**620**) by the data-gathering utility **614** to the Web server **608**. In this example, the logs are sent (**620**) using a SOAP method invocation. The Web server **608** puts (**622**) the logs into the database **610**, in this example via a SQL "INSERT INTO" command.

[**0075**] The data-gathering utility **614** may be configured to monitor the client system **600** for any software additions that are a source of additional logs. If software is added (**624**), the data-gathering utility **614** may add (**626**) this new software to the list of log sources. Subsequently, log data from this new application will be added to the database **610** as previously described (e.g., receiving **618**, sending **620**, and inserting **620**).

[**0076**] In some cases, the client **600** may need to retrieve logs from the database **610**. The data-gathering utility **614** may facilitate log retrieval by accepting a query (**628**) from the user via hardware coupled to the OS **604** (e.g., a keyboard and mouse). The query need not be limited to selecting logs from this particular client **600**. For example, the query may be used to retrieve logs from a transaction that was distributed across many network entities. The query is sent (**630**) to the Web server **608** via a SOAP method. The SOAP method is used to form a SQL "SELECT FROM" for selecting (**632**) the desired logging data. The result is sent (**634**) to the Web server **608**, which formats and sends (**636**) the result to the data-gathering utility **614** as part of the HTTP response. The data-gathering utility **614** can thereafter show (**638**) the results to the user.

[**0077**] In reference now to **FIG. 7**, a flowchart illustrates a procedure **700** that may be used by a client data processing arrangement for handling log data according to embodiments of the present invention. A data-gathering utility gathers (**702**) log data from one or more applications executing on the data processing arrangement. The log data is sent (**704**) to a log server via a network for insertion into a database accessible by the log server. The client is adapted to receive (**706**) via the network, an alert describing a malfunction of the data processing arrangement. This alert is generated in response to log data sent to the log server. The client may be directed to download (**708**) a software component that is configured to repair the malfunction based on data contained in the alert.

[**0078**] In reference now to **FIG. 8**, a flowchart illustrates a procedure **800** that may be used by a log server for handling log data according to embodiments of the present invention. The log server is configured to receive (**802**), via a network, log data from a plurality of client data processing arrangements. The log data is stored (**804**) in a database accessible by the log server.

[**0079**] The log server determines (**806**) a status of at least one of the client data processing arrangements based the log data received from the client data processing arrangements. For example, the log server may parse data received from the client arrangements and search for identifying data that indicates errors, problems, and/or correct operation. The search may involve specific words, may involve statistical and/or lexical analysis, and may involve comparing the data between various machines to establish non-conforming behavior. The determination (**806**) may also involve determining that expected data is lacking, such as when a machine or process is hung. Once the log server has determined (**806**) a change in state of a data processing arrangement, the log server sends (**808**) an alert to the affected client data processing arrangement based on this determination of status.

[**0080**] Hardware, firmware, software or a combination thereof may be used to perform the various functions and operations described herein of a distributed-computation program. Articles of manufacture encompassing code to carry out functions associated with the present invention are intended to encompass a computer program that exists permanently or temporarily on any computer-usable medium or in any transmitting medium, which transmits such a program. Transmitting mediums include, but are not limited to, transmissions via wireless/radio wave communication networks, the Internet, intranets, telephone/modem-based network communication, hard-wired/cabled communication network, satellite communication, and other stationary or mobile network systems/communication links. From the description provided herein, those skilled in the art

will be readily able to combine software created as described with appropriate general purpose or special purpose computer hardware to create a distributed-computation system, apparatus, and method in accordance with the present invention.

[0081] The foregoing description of the example embodiments of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. It is intended that the scope of the invention not be limited with this detailed description, but rather the scope of the invention is defined by the claims appended hereto.

What is claimed is:

1. A processor-based method for logging data, comprising:

gathering, via a data-gathering utility executing on a first data-processing arrangement, log data from one or more applications executing on the first data-processing arrangement;

sending, via a network, the log data to a Web services interface of a log server;

storing the log data in a database accessible by the log server; and

determining status of the first data processing arrangement based on the log data stored in the database.

2. The method of claim 1, further comprising:

gathering via a plurality of data-gathering applications executing on respective other data processing arrangements, other log data associated with applications running on the respective data processing arrangements; and

storing the other log data in the database via the Web services interface of the log server.

3. The method of claim 2, wherein determining the status of the first data processing arrangement comprises comparing the log data with the other log data received from the other data processing arrangements.

4. The method of claim 1, wherein storing the log data in the database comprises placing the log data in a table of a relational database, wherein the table is indexed by a user ID associated with the first data-processing arrangement.

5. The method of claim 1, wherein storing the log data in the database comprises placing the log data in a table of a relational database, wherein the table is indexed by a transaction ID associated with a transaction performed by at least one of the applications executing on the first data-processing arrangement.

6. The method of claim 1, wherein storing the log data in the database comprises placing the log data in a table of a relational database, wherein the table is indexed by a machine ID associated with the first data-processing arrangement.

7. The method of claim 1, further comprising sending, via the network, an alert to the first data processing arrangement based on determining the status of the first data processing arrangement.

8. The method of claim 7, further comprising downloading a software component to the first data processing arrangement based on data contained in the alert, the software component configured to repair a malfunction indicated by the status.

9. The method of claim 1, further comprising:

sending a query to the Web services interface of the log server; and

retrieving a selected set of the log data from the database based on the query.

10. The method of claim 1, further comprising:

detecting, via the data-gathering utility, the installation of an additional application on the first data processing arrangement; and

gathering, via the data-gathering utility, log data from the additional application based on detection of the additional application.

11. The method of claim 10, wherein detecting the installation of an additional application comprises locating an application registry entry created as a result of the installation of the additional application.

12. The method of claim 1, further comprising:

sending, via the network, a command to the data-gathering utility of the first data processing arrangement; and

changing an amount of data gathered by the data-gathering utility in response to the command.

13. The method of claim 12, wherein changing the amount of data gathered by the data-gathering utility comprises at least one of activating and deactivating logging associated with at least one of the applications of the data processing arrangement.

14. The method of claim 12, wherein changing the amount of data gathered by the data-gathering utility comprises changing a debug level associated at least one of the applications of the data processing arrangement.

15. A processor-based method for handling log data, comprising:

associating a unique identifier associated with a transaction involving two or more data processing arrangements coupled via a network;

gathering log data associated with the transaction via data-gathering utilities executing on each of the data processing arrangements, wherein the log data includes the unique identifier associated with the transaction;

sending, via the network, the log data to a Web services interface of a log server;

storing the log data in a database accessible by the log server;

sending, to the Web services interface of the log server, a query configured to select a set of the log data from the database based on the unique identifier associated with the log data; and

retrieving the selected set of data from the log server.

16. The method of claim 15, further comprising associating the data-gathering utilities with one or more applications executing on the respective data processing arrangements so that the data-gathering utilities receive log data from the one or more applications.

17. The method of claim 16, further comprising:

detecting, via the data-gathering utilities, the installation of additional applications on the data processing arrangements; and

associating the data-gathering utilities with the additional applications of the respective data processing arrangements so that the data-gathering utilities receive log data from the additional applications.

18. The method of claim 15, further comprising:

sending, via the network, a command to a selected data-gathering utility of the data-gathering utilities; and

changing an amount of data gathered by the selected data-gathering utility in response to the command.

19. The method of claim 18, wherein changing the amount of data gathered by the selected data-gathering utility comprises at least one of activating and deactivating logging associated with one or more applications of the associated data processing arrangement.

20. The method of claim 18, wherein changing the rate of data gathering of the selected data-gathering utility comprises changing a debug level associated with one or more applications of the associated data processing arrangement.

21. A processor-readable medium, comprising:

a program storage device configured with instructions for causing a processor of a data processing arrangement to perform the operations of,

gathering log data from one or more applications executing on the data processing arrangement;

sending, via a network, the log data to a log server for insertion into a database accessible by the log server; and

receiving, via the network, an alert describing a malfunction of the data processing arrangement, the malfunction determined based on the log data sent to the log server.

22. The processor-readable medium of claim 21, wherein the operations further comprise downloading a software component to the data processing arrangement based on data contained in the alert, the software component configured to repair the malfunction.

23. The processor-readable medium of claim 21, wherein the operations further comprise:

sending a query to a Web services interface of the log server; and

retrieving a selected set of stored log data from the database based on the query.

24. The processor-readable medium of claim 21, wherein the operations further comprise:

detecting the installation of an additional application on the data processing arrangement; and

gathering log data from the additional application based on detection of the additional application.

25. The processor-readable medium of claim 21, wherein the operations further comprise:

receiving, via the network a command targeted for the data processing arrangement; and

changing a rate of data gathering in response to the command.

26. The processor-readable medium of claim 25, wherein changing the rate of data gathering comprises at least one of activating and deactivating logging associated with at least one of the applications of the data processing arrangement.

27. The processor-readable medium of claim 25, wherein changing the rate of data gathering comprises changing a debug level associated at least one of the applications of the data processing arrangement.

28. A processor-readable medium, comprising:

a program storage device configured with instructions for causing a processor of a data processing arrangement to perform the operations of,

receiving, via a network, log data from a plurality of client data processing arrangements, wherein each client data processing arrangement includes a data-gathering utility that gathers data from applications of the respective client data processing arrangement;

storing the log data in a database accessible by the data processing arrangement;

determining a status of at least one of the client data processing arrangements based the log data received from the client data processing arrangements; and

sending, via the network, an alert to the at least one client data processing arrangement based on determining the status of the at least one client data processing arrangement.

29. The processor-readable medium of claim 28, wherein the operations further comprise providing a downloadable software component to the at least one client data processing arrangement based on data contained in the alert, the software component configured to repair a malfunction indicated by the status of the at least one client data processing arrangement.

30. The processor-readable medium of claim 28, wherein the operations further comprise:

receiving a query at a Web services interface of the data processing arrangement;

retrieving a selected set of the log data from the database based on the query; and

sending the selected set of the log data to an originator of the query.

31. The processor-readable medium of claim 28, wherein the operations further comprise sending, via the network, a command to the data-gathering utility of a selected client data processing arrangement, the command configured to change an amount of data gathered by the data-gathering utility of the selected client data processing arrangement.

32. The processor-readable medium of claim 31, wherein changing the amount of data gathered by the data-gathering utility comprises at least one of activating and deactivating logging associated with at least one application of the selected client data processing arrangement.

33. The processor-readable medium of claim 31, wherein changing the amount of data gathered by the data-gathering utility comprises changing a debug level associated at least application of the selected client data processing arrangement.

34. A system, comprising:

means for gathering log data from one or more applications of a first data-processing arrangement;

means for sending, via a network, the log data to a log server;

means for storing the log data in a database accessible by the log server;

means for comparing the log data with other log data received from additional data processing arrangements; and

means for determining malfunctions of the first data processing arrangement based on the comparison of the log data.

* * * * *