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(54) **Title:** REMOTE DATA STORAGE MANAGEMENT SYSTEM

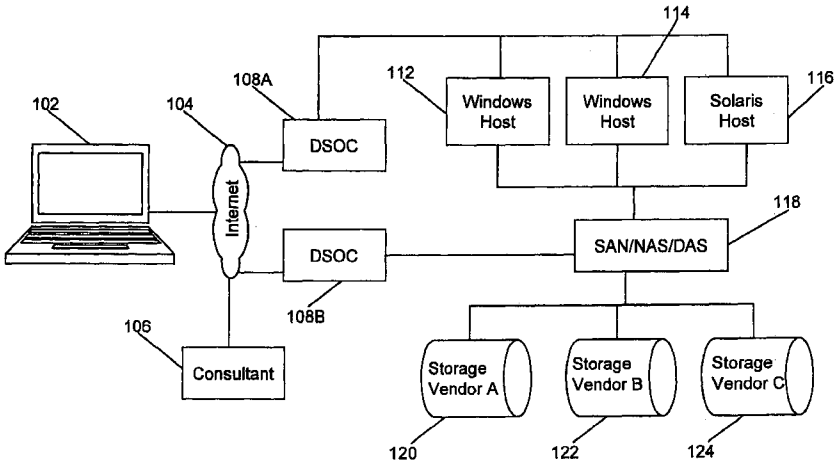

FIG. 1

(57) **Abstract:** The embodiments herein provide a dynamic remote data storage management system and method to deliver storage related services to the users. Plurality of signaling enabled distributed and managed object software (SEDMOS) are distributed and connected together through a network to a user and to a storage environment to collect and analyze fault, configuration, accounting, performance and security (FCAPS) data. Each SEDMOS is self configured, customized and embedded with software so that one SEDMOS may act as a collector to acquire information related to user storage requirement while another SEDMOS may act as a controller to perform FCAPS management of storage resources based on business policies and storage requirement of user. A work flow engines creates a workflow to deliver the storage related services to the user.

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REMOTE DATA STORAGE MANAGEMENT SYSTEM

BACKGROUND

Technical field

[0001] The embodiments herein invention generally relate to a data storage management system and more specifically to an online remote data storage management system designed to deliver data storage services required for user, using a storage dial up platform and storage intelligent network dynamically and automatically.

Description of the Related Art

[0002] The Computer storage, the computer memory, and often casually the memory refer to the computer components, devices and the recording media that retain the digital data used for computing for some interval of time. The Computer storage provides one of the core functions of the modern computer, such as retaining the information.

[0003] The multiple forms of storage have been invented based on various natural phenomena. Until now no practical universal storage medium exists and all the types of storage available now have some drawbacks. A computer system usually contains several kinds of storage, each with an individual purpose.

[0004] A primary storage system is directly connected to the central processing unit of the computer. The secondary storage requires the computer to use its input and output channels to access the information, and is used for long-term storage of persistent information. However the secondary storage devices are used in most computer operating systems as a virtual memory device to artificially increase the apparent amount of main

memory in the computer. The secondary storage is also known as a mass storage device.

[0005] The off-line storage device is a system in which the storage medium may be removed easily from the storage device. The off-line storage is used to transfer data between the various systems and to archive the stored data for future reference. In the modern computers, Compact Discs (CD), Digital Versatile Disc (DVD), memory cards, flash memory devices including Universal Serial Bus (USB) drive device, floppy disk, zip disks and magnetic tapes, are commonly used for off-line mass storage purposes. "Hot-pluggable" USB hard disks are also available. The off-line storage devices used in the past include punched cards, micro forms and removable Winchester disk drums.

[0006] The tertiary storage is a system in which an industrial robot will "mount" (connect) or "dismount" the off-line mass storage media according to the requirement and demand of the computer operating system. The tertiary storage is used in the large computer systems at the enterprise storage industry and also in the scientific computing field. The tertiary storage is used extensively in business computer networks.

[0007] The database storage is a system in which the information acquired by the computers is stored in large databases, data banks, data ware houses or data vaults. In the database storage system, the large amounts of storage devices are packed and stored throughout a series of shelves that are arranged in a room, usually an office, and are linked together. The information in database storage systems may be accessed by a super computer, main frame computer or personal computer. The databases, data banks, and data warehouses, etc, may only be accessed by the authorized users.

[0008] The network storage is any type of computer storage that may be accessed over a computer network to acquire information. The network storage enables to centralize

the information management in an organization, and to reduce the duplication of information.

[0009] The network attached storage is secondary or tertiary storage attached to a computer which another computer can access at file level over a local area network, a private wide area network or in the case of online file storage, over the internet.

[0010] The storage area network provides other computers with storage capacity over a network. The main difference between the Network Attached Storage (NAS) and the Storage Area Network (SAN) is that the former presents and manages file systems to the client computers, while the SAN permits the access to the disks at block addressing level, enabling the attaching systems to manage data or file systems within the installed memory capacity.

[0011] The network computers are the computers that do not include the internal secondary storage devices. Instead, the documents and other data are stored on a network-attached storage.

[0012] The Network-attached storage was introduced with the early file sharing Novell's Netware server operating system and Netware core protocol (NCP). In the UNIX world, the Sun Microsystems' 1984 release of Network File System (NFS) allowed network servers to share their storage space with networked clients. 3Com's 3server and 3+Share software was the first servers with built –in purpose for the open system servers. The 3Com and the Microsoft have developed the LAN manager software and protocol to improve the market. Inspired by the success of the file servers from the Novell, IBM and Sun, several firms developed dedicated file servers. While 3server was among the first company to build a dedicated NAS for desktop operating systems, the Auspex Systems was one of the first to develop a dedicated NFS server for use in the UNIX market. In 1990s, a group of Auspex

engineers split away to create the integrated Network Appliance, "filer," to support both the Windows and the UNIX operating systems to develop a market for the proprietary NAS arrays. In the early 2000s, researches started to offer alternative solutions to the single filer solutions in the form of clustered NAS such as Exanet, IBRIX, Isilon, Polyserve, etc.

[0013] The availability of the data may greatly be increased with NAS when NAS is provided with built-in RAID and clustering technology. The efficiency and the performance may be increased by NAS because the file serving is done by the NAS and not done by a server which is responsible for doing other processing also. The performance of NAS devices is dependent heavily on the speed and traffic on the network and the amount of cache memory: Random Access Memory (RAM) in the NAS computers or devices.

[0014] The NAS is effectively a server in itself, with all major components of a typical PC like Central Processing Unit (CPU), motherboard, RAM, etc. The reliability of NAS is based on the internal design of the server. A NAS without redundant data access paths, redundant controllers, redundant power supplies, is probably less reliable than a disc attached storage (DAS) connected to a server having redundancy for its major components.

[0015] Due to the multi protocol, and the reduced CPU and Operating System (OS) layer, the NAS has its limitations compared to the Direct-Attached Storage DAS/FC systems. If the NAS is occupied with too many users, too many I/O operations, or CPU processing power that is too demanding, the NAS reaches its limitations. A server system is easily upgraded by adding one or more servers into a cluster, so CPU power can be upgraded, while the NAS is limited to its own hardware, which is in most cases not upgradeable.

[0016] The key difference between Direct-Attached Storage (DAS) and NAS is that DAS is simply an extension to an existing server and is not networked while NAS sits on a

network as its own entity; it is easier to share files with NAS. The NAS typically has less CPU and I/O power compared to DAS.

[0017] In an increasingly demanding and competitive business landscape, effective data management is essential to the success of the enterprise. The data availability, from any location, gives employees, partners and customers, the up-to-the-minute information they need to work productively, to make timely decisions and to meet business goals. Across industries, the enterprises of all types and sizes face similar data storage challenges. They need intelligent data and storage management capabilities to manage growth with limited administration resources. They must consolidate storage and improve resource utilization for many applications across multiple server and storage platforms. When they deploy storage and data management systems to address their needs, they must reduce both acquisition and management costs.

[0018] These enterprise storage systems deliver a unified storage architecture with versatility to simultaneously meet diverse needs—SAN and NAS, primary and secondary storage—while providing high levels of availability. N5000 systems handle complex requirements in a way that actually simplifies the storage infrastructure and improves productivity.

[0019] The storage infrastructure is the backbone of present day business houses. Lot of new technologies and innovations are being developed in this domain to exploit maximum Return on Investment (ROI).

[0020] The remote management of POTS (Plain Old Telephone System) and PANs (Personal Area Networks) is mature and widely deployed. Although the storage has been networked for over a decade, the storage resource management, is not at the same level of

maturity and the remote storage discovery, monitoring, management and optimization are just emerging. While Fault, Configuration, Accounting (of resource utilization), Performance and Security (FCAPS) management is a standard fare in POTS and PANs, it is not widely recognized as a requirement by the prominent storage vendors. There are no common and easy methods to capture the required information easily. Even when some vendors provide them, they use proprietary or complex interfaces and lack standard way of delivering this information to make remote service management possible.

[0021] In addition, the storage resource optimization to meet disparate application needs (response time sensitivity, throughput intensive and large capacity demanding) requires application to spindle FCAPS information from various types of devices and software applications that are involved so that the end-to-end optimization may be performed. Otherwise the local optimizations performed at server level, network level and storage level may often lead to less than desired result.

[0022] Next generation remote storage management system must provide a simple way to assure FCAPS data collection and control of various elements involved in application to storage path. Then the FCAPS data provides a vehicle to provide remote analysis, management and optimization to match the application requirements with appropriate storage resources.

[0023] Thus the currently available storage systems are not able to adjust to the application needs dynamically. The currently available heterogeneous storage complexity/ matrix are difficult to manage and are labour intensive. The implementation of changes in any storage systems in a continuous and non disruptive manner is very difficult. The currently available data storage management systems have manual or multiple vendor

specific tools and services to collect data related to storage management services. The systems deliver the storage related services through labour intensive service delivery kits. The problems related to the storage services are diagnosed by the domain experts. The pluralities of the different functional units are regulated manually to co-ordinate various functions in the enterprise to delver a storage related service. None of the currently available data storage management systems provides a dynamic FCAPS management to align application needs with appropriate storage and other resources. There is no system to allow the delivery of assessment, management and optimization service remotely.

[0024] Hence there is a need to develop a remote management system and method to collect FCAPS management data dynamically and remotely to assess, manage and optimize storage resources and to deliver assessment, management and optimization of storage related services. Also there is a further need to develop a signaling scheme to perform alerting, addressing, supervision and mediation operations to carryout remote monitoring and management of the storage systems.

SUMMARY

[0025] The primary object of the present invention is to develop a system to provide world class storage related services easily and dynamically.

[0026] Another object of the present invention is to develop a system to create, deliver, assess and manage the storage related services easily and effectively using a dial up platform.

[0027] Yet another object of the present invention is to collect FCAPS management

data dynamically and remotely.

[0028] Yet another object of the present invention is to develop a remote data storage management system to assess, manage and optimize storage resources and to deliver assessment, management and optimization of storage related services effectively.

[0029] Yet another objective of the present invention is to develop a remote data storage management system with a signaling mechanism to perform alerting, addressing, supervision and mediation operations to carryout remote monitoring and management of the storage systems.

[0030] Yet another object of the present invention is to develop a remote data storage management system to provide a simple way to assure FCAPS data collection and control of various elements involved in application to storage path.

[0031] Yet another object of the present invention is to develop a remote data storage management system to allocate storage system resources dynamically with respect to the demands and the requirements of storage applications, and end users.

[0032] Yet another object of the present invention is to develop a remote data storage management system to create and deliver storage related services with value added tools.

[0033] Yet another object of the present invention is to develop a remote data storage management system to deliver subscription based services.

[0034] Yet another object of the present invention is to develop a remote data storage management system to provide Remotely Managed Storage FCAPS (Fault, Configuration, Accounting, Performance and Security) services.

[0035] Yet another object of the present invention is to develop a remote data storage management system to create next generation storage service creation, delivery and

assurance platform.

[0036] Yet another object of the present invention is to develop a remote data storage management system to assess storage infrastructure for risks, vulnerability to disasters and compliance to best practices to improve the data availability, to utilize storage resources optimally, to ensure compliance of best practices and to provide scalability.

[0037] Yet another object of the present invention is to develop a remote data storage management system to perform the data consolidation operations to unify the disparate disc attached storage (DAS)/islands of the storage resources to simplify the data storage management operations and to reduce the complexity in the data storage management processes to utilize the storage system resources effectively to improve the usage of the storage system resources.

[0038] Yet another object of the present invention is to develop a remote data storage management system to perform the data consolidation operations to unify the disparate DAS/islands of the storage resources to improve the data backup and recovery operations and to simplify the disaster recovery operations.

[0039] Yet another object of the present invention is to develop a remote data storage management system to ensure the availability of the data using the processes and the technologies to protect the data from the logical and the physical failures to ensure that the data recovery is within the defined window and the data recovery is adhered to the compliance requirements.

[0040] Yet another object of the present invention is to develop a remote data storage management system to ensure that the data is recovered effectively during the logical and the physical failures to ensure the business continuity.

[0041] Yet another object of the present invention is to develop a remote data storage management system to provide a data migration service to focus on moving a data from one device to another and then redirecting all or part of I/O to the new device to avoid the technology obsolescence, to enable the data classification and to change the storage architecture.

[0042] Yet another object of the present invention is to develop a remote data storage management system to provide a storage management service for measuring, monitoring and optimizing the storage systems.

[0043] Yet another object of the present invention is to develop a remote data storage management system to perform the data audit services in the areas of data storage, data protection and data recovery to measure the deviations from the best standard practices in the industry to enhance an application performance, to utilize the storage resources optimally, to improve the protection to an investment, to increase the revenue opportunity, to ensure the continuity of a business operation, to increase the efficiency and the performance of a system, to improve the availability of an information, to simplify the management of the storage related services and to reduce the costs of services offered to the users

[0044] The various embodiments of the present invention provide a system and method for a remote data storage management to detect, monitor, manage and optimize the storage systems and resources.

[0045] According to one embodiment of the present invention, plurality of signaling enabled distributed and managed object software (SEDMOS) are distributed and connected together through a network to a user and to a storage environment to collect and analyze the fault, configuration, accounting, performance and security (FCAPS) data. Each SEDMOS is

self configured, customized and embedded with an application software so that one SEDMOS may act as a collector to acquire the information related to the user storage requirement, while another SEDMOS may act as a controller to collect the acquired data to perform the fault, configuration, accounting, performance and security (FCAPS) management of the storage resources based on the business policies and the storage requirement of a user. One SEDMOS is connected to the plurality of users through an Internet protocol (IP) network. Another SEDMOS is connected to a plurality of storage vendors through a storage area network (SAN). The collected data includes the information related to the utilization capacity, the frequency of usage, the priority, the hierarchicy, the utilization pattern of the application and the storage services. A communication and signaling infrastructure is provided to set up a communication path between the SEDMOS objects.

[0046] A signaling enabled work flow engine generates a workflow to execute a service based on the analysis of the data collected data by the SEDMOS. The workflow engine creates a workflow to execute the allocation, delivery and the management of the storage resources with respect to the user based on the storage requirements and services that are estimated with respect to the data collected by the SEDMOS objects. A centralized command and control center accesses and analyzes the data collected by the SEDMOS to carry out a remote FCAPS management of the storage services and resources with respect to the users. The centralized command and control centre allows discovering, analyzing and assessing the available options to provide a remote control operation to modify the storage resource allocation operation dynamically.

[0047] The workflow engine generates a workflow by forming two infrastructure layers. One infrastructure layer is created to collect the entire FCAPS data from all of the

users and the service resource providers. Another infrastructure layer is created to provide a service to optimize the storage resources with respect to the multiple users based on the collected data and the requirements of the users. The available storage resource infrastructures are optimized end-to-end based on the collected FCAPS data to align the resources to meet the requirements of the users.

[0048] According to another embodiment of the present invention, a dynamic remote data storage management method is provided using a remote management system to deliver the storage related services to the users. The method is used to detect, monitor, manage and optimize the storage systems and the resources.

[0049] Thus the various embodiments of the present invention provide a dynamic remote data storage management system and method to deliver the storage related services to the users according to the need and the requirement of the user. The storage resources are allocated and changed dynamically and automatically by creating two infrastructure layers. One layer is created to allow the creation, the delivery and the assurance of the storage services (assessment, management and optimization) that monitor the FCAPS data from all the devices and elements that align application needs to the storage resource allocation and utilization operations. The second infrastructure layer is created to generate the SEDMOS objects that collect and/or control the data from the devices involved in the storage services with high reliability, availability and security. The online remote data storage management system and method enables the remote service creation, the FCAPS management, the delivery and the assurance of the storage related services to the user based on the received request or on demand.

[0050] The remote data storage management system of the present invention

enhances the performance of an application and optimizes the usage of the storage resources. The system protects the investment, increases the revenue opportunity, enhances the efficiency and the performance of the storage delivery process, improves the access and availability of data at any point of time, simplifies the data storage management process and reduces the cost of data storage.

[0051] These and other aspects of the embodiments herein will be better appreciated and understood when considered in conjunction with the following description and the accompanying drawings. It should be understood, however, that the following descriptions, while indicating preferred embodiments and numerous specific details thereof, are given by way of illustration and not of limitation. Many changes and modifications may be made within the scope of the embodiments herein without departing from the spirit thereof, and the embodiments herein include all such modifications.

BRIEF DESCRIPTION OF THE DRAWINGS

[0052] The embodiments herein will be better understood from the following detailed description with reference to the drawings, in which:

[0053] FIG. 1 illustrates a block diagram of an online remote data storage management system according to one embodiment of the present invention.

[0054] FIG. 2 illustrates a functional block diagram of SEDMOS in an online remote data storage management system according to one embodiment of the present invention.

[0055] FIG. 3 illustrates a functional block diagram of a work flow engine in an online remote data storage management system according to one embodiment of the present

invention.

[0056] FIG. 4 illustrates a schematic block diagram of a work flow engine in an online remote data storage management system according to one embodiment of the present invention.

[0057] Although specific features of the present invention are shown in some drawings and not in others. This is done for convenience only as each feature may be combined with any or all of the other features in accordance with the present invention.

DETAILED DESCRIPTION

[0058] The embodiments herein and the various features and advantageous details thereof are explained more fully with reference to the non-limiting embodiments that are illustrated in the accompanying drawings and detailed in the following description. Descriptions of well-known components and processing techniques are omitted so as to not unnecessarily obscure the embodiments herein. The examples used herein are intended merely to facilitate an understanding of ways in which the embodiments herein may be practiced and to further enable those of skill in the art to practice the embodiments herein. Accordingly, the examples should not be construed as limiting the scope of the embodiments herein.

[0059] The various embodiments of the present invention provide an online data storage management system and method to create an intelligent distributed object model to support creation, delivery and assurance of the storage related services using a distributed remote service delivery platform. The data storage management system performs the storage

monitoring, management and optimization processes using an intelligent distributed remote management platform with self-healing and Fault, Configuration, Accounting (of resource utilization), Performance and Security (FCAPS) operations built in an Object Framework.

[0060] According to one embodiment of the present invention, the online data storage management system of the present invention provides a dynamic FCAPS management to align the application needs with the appropriate storage and other resources (servers, switches etc.). The data storage management system includes a set of Signaling Enabled Distributed and Managed Object Software (SEDMOS) called collectors and controllers, a distributed object infrastructure, a communication and signaling infrastructure and a centralized command and control center.

[0061] The SEDMOS are programmed with a narrow set of commands to collect the FCAPS information or configure specific the FCAPS elements. The distributed object infrastructure allows the distribution, monitoring and management of the SEDMOS themselves. The communication and signaling infrastructure enables to set up the paths between the SEDMOS and the centralized command and control center. The centralized command and control center provides access to the collected FCAPS information and carries out the analysis of information collected to execute remote FCAPS management of the components from application to data storage path based on the business policies on the application and the resource storage alignment.

[0062] The enterprises or users whether they are large or small, are in need of a FCAPS management infrastructure that is used easily, may be scaled to demand and requirements of the user. Further the FCAPS management infrastructure is affordable and acceptable to each user based on the cost and policy requirement of the individual users.

[0063] Each SEDMOS is programmed and configured so that one SEDMOS may act as a collector to acquire the specific data from the users through a network. The network may be an IP network or SAN network. Each SEDMOS is treated as a specialized collector/controller of a very specific element in the IT infrastructure. The SEDMOS are distributed and connected over an IP network to discover, collect and control the FCAPS information related to the various elements from an application to data storage of each user connected either with an IP or a SAN network. The SEDMOS are especially programmed to collect/control a specific element.

[0064] In order to achieve a reliable and robust distribution of the SEDMOS objects on a large scale, all SEDMOS objects are programmed to manage their own FCAPS process. The distributed object infrastructure enables to create each SEDMOS object with same genetic character to allow each SEDMOS to provide the respective self FCAPS information for the remote monitoring and the management. Each SEDMOS is provided with an inbuilt program to collect and provide the FCAPS information necessary to provide the robustness, security and availability of the stored data. Each SEDMOS is installed with an inherent self repairing capability during the generation of faults in the distribution of the SEDMOS.

[0065] Each SEDMOS is built with a customizable communication and signaling capability so that each SEDMOS is able to communicate with other SEDMOS and also with the remote central command and control center. An application programmable interface (API) is provided to customize the collection and the control processes performed by the SEDMOS.

[0066] The remote data storage management system has a communications and signaling infrastructure to provide communication between the remote central command and

control centre and the distributed SEDMOS. The communication and signaling infrastructure has a robust, secure and highly available communication unit to establish a communication between the distributed SEDMOS and the control centre. The communication infrastructure is also used to provide the communication between the different SEDMOS objects. The signaling mechanism delivers the addressing, alerting, supervision and mediation processes to assure that each SEDMOS is operated as designed and customized in a totally distributed environment.

[0067] The centralized command and control center allows the storage service creation, delivery and assurance operations using the information collected by the SEDMOS objects. The purpose of the SEDMOS infrastructure is to collect the data related to the components from the application to data storage path, to understand the business goals and priorities and to align the storage resources to meet the needs of application requirements based on the input business policies. The centralized command and control center enables to discover, analyze and assess the available options. The centralized command and control center is also used to remotely modify the allocation of the storage resources based on the analysis of the acquired data.

[0068] Thus the remote data storage management system performs the delivery of assessment, management, and optimization services related to a data storage system through a remote services platform in which the SEDMOS are used as key elements to collect data and to control the devices in the field. The SEDMOS are programmed and customized to perform the specialized jobs.

[0069] The services are modeled as a workflow among a network of objects. The services are created by designing the object network with a workflow engine that drives the

work-flow. The higher levels of services are generated by composing multiple lower levels of services. Each service has a built-in FCAPS mechanism for control so that each service is managed over a network.

[0070] In the above model, two infrastructure layers are used to create and deliver a storage related service to a user. One infrastructure layer is created to collect the data from a remote data center and to provide control in a reliable and extensible fashion. In the second layer the acquired/collected data are used to provide the resource optimization services based on the needs of the consumers utilizing the resources. In the second layer used for providing the resource optimization operation, the FCAPS data are collected from all the devices and the infrastructure layer is optimized end-to-end to align the resources to meet the consumer needs. Thus the need for a local optimization process is avoided at the user end by performing the end-to-end optimizations of the infrastructure layer. In the storage resource optimization process, the storage resources are optimized with respect to the consumer applications.

[0071] The storage service is modeled as a work-flow in which the data collectors, analyzers, controllers, administrators and tools collaborate with each other to accomplish a goal. The smaller low-level services are specialized workflows that are created to accomplish the specific tasks such as collecting the FCAPS data from all the consumers and the resource providers. The higher levels of services correlate and align various pieces of information from multiple lower level services to provide the higher level consumers with multiple lower level services. Every service has specific inputs, methods and outputs to accomplish the goals set for the specific service. The services may be a data storage service, a data backup service, a data recovery service, a data migration service, a data security service, a subscription based

service, a value added service through partner services, etc.

[0072] The first layer of infrastructure is aimed at creating a robust, highly available, secure and reliable distributed object (SEDMOS) infrastructure for collecting data from the large number of distributed devices in IT and also an infrastructure to control them. The FCAPS management of the distributed objects (SEDMOS) are performed to provide the robustness, high availability, security and reliability of the storage related services delivered to the users.

[0073] The FCAPS management of the SEDMOS is performed. A signaling scheme, which is used to execute the alerting, addressing, supervision and mediation operations, is provided to allow the remote monitoring and management of the SEDMOS objects.

[0074] A suitable application programming interface (API) is arranged to customize the collection and/or the control methods to permit the scalability of creating the required SEDMOS objects. A uniform FCAPS model in each SEDMOS helps to achieve a common infrastructure.

[0075] According to one embodiment of the present invention, a remote data storage management system is provided to enable the storage monitoring, management and optimization processes using an intelligent distributed remote management platform with inbuilt correction property and SEDMOS with built-in FCAPS management technique.

[0076] According to one embodiment of the present invention, a remote data storage management system for detecting, monitoring, managing and optimizing the storage systems contains a plurality of signaling enabled distributed and managed object software (SEDMOS). The system has a compiler to create the SEDMOS objects. The SEDMOS are distributed and connected together through a network to a user and to a storage environment

to collect and analyze the fault, configuration, accounting, performance and security (FCAPS) data. Each SEDMOS is self configurable, customized and embedded with application software so that one SEDMOS may act as a collector to acquire the information related to the user storage requirement, while another SEDMOS may act as a controller to collect the acquired data to perform the fault, configuration, accounting, performance and security (FCAPS) management of the storage resources based on the input business policies and the storage requirement of the user. The collected data includes the information related to the utilization capacity, the frequency of usage, the priority, the hierarchy, the utilization pattern of an application and the storage services. The SEDMOS acting as collectors are connected to the users through an internet protocol network. The SEDMOS acting as collectors are connected to the multiple storage vendors through a storage area network.

[0077] Each SEDMOS module contains a compiler, a programming language, a FCAPS environment and signaling enabled FCAPS objects, a signaling unit and a process definition language. The compiler generates a FCAPS environment and signaling enabled FCAPS objects to provide the remote analysis, management and optimization of the storage resources with the application requirements based on the input business policies on the application requirements and the resource storage alignment.

[0078] A programming language is embedded in the SEDMOS to make one SEDMOS to act as a collector to acquire the FCAPS data related to the storage resources and applications and to make another SEDMOS to act as a controller to carry out the FCAPS management of the storage resources with respect to the application requirements dynamically.

[0079] The signaling unit enables communication between the distributed SEDMOS

objects. The signaling unit also establishes communication between the SEDMOS and the central command and control centre. The signaling unit performs the addressing, alerting, supervision and mediation processes to ensure that all SEDMOS are operated as programmed in a totally distributed and managed environment.

[0080] Each SEDMOS has a process definition language to create a process to optimize the storage resources with respect to the application requirement based on the collected data and the input business policies. The process definition language creates a process to configure a security protocol for a data transfer to the storage system from the user system. The process definition language generates a signaling enabled object interface to create a process to allocate the data storage resources optimally with respect to the user storage requirements.

[0081] The signaling enabled work flow engine is connected to the central command and control center through a network to design a workflow to execute a service based on the analysis of the data collected by the SEDMOS. The workflow engine creates a workflow to execute the allocation, the delivery and the management of the storage resources with respect to the user based on the storage requirements and services that are estimated with respect to the data collected by the SEDMOS units. The workflow engine generates a workflow to deliver a required storage related service to the user. The required service is a storage service which is modeled as a work flow in which the data collectors, the analyzers, the controllers, the administrators and the tools collaborate as a network of distributed objects to provide the desired storage related service.

[0082] The workflow engine creates a workflow by forming two infrastructure layers. One infrastructure layer is created to collect the entire FCAPS data from all users and service

resource providers. Another infrastructure layer is created to provide a service to optimize the storage resources with respect to the multiple users based on the collected data and the requirements of the users. The available storage resource infrastructures are optimized end-to-end based on the collected FCAPS data to align the resources to meet the requirements of the users.

[0083] A storage definition tool is connected to the workflow engine through an application server. The storage definition tool is an application to estimate the storage requirements and the services required by the end user based on the data collected through the SEDMOS objects. The application server receives and forwards the estimated storage management information and the services to the workflow engine. An external application is executed on said application server to select a suitable and appropriate application for generating a workflow based on the data collected by the SEDMOS object. An application database is connected to the workflow engine and to the application server to store the data related to the services, the tools, the licenses, the users and their roles, the policy and the service requests.

[0084] A remote control facility is connected to the SEDMOS units to provide a manual intervention and to control the SEDMOS objects. The SEDMOS may be customized to connect with a remote control facility.

[0085] A centralized command and control center is connected to the SEDMOS though internet to access and to analyze the data collected by the SEDMOS to carry out the remote FCAPS management of the storage services and resources with respect to the users. The centralized command and control centre discovers, analyzes and assesses the available options to provide a remote control operation to modify the storage resource allocation

process dynamically.

[0086] According to another embodiment of the present invention, a dynamic remote data storage management method is provided to deliver the storage monitoring, management and optimization services using An intelligent distributed remote management platform with in–built self-correction property and the SEDMOS objects with built-in FCAPS management technique.

[0087] The SEDMOS are communicatively connected with the user systems through an internet protocol (IP) network to collect the information related to applications and user systems. The SEDMOS acting as collectors are connected to the storage vendors through a storage area net work. The user systems are connected to the storage vendor products through the storage area network or IP network.

[0088] Each SEDMOS is programmed to act as a collector to acquire FCAPS data related to the user applications and systems or as a controller to perform a FCAPS management process using the collected data. The collected FCAPS information related to the system and the user application includes fault, configuration and accounting of resource utilization, performance and security (FCAPS) management information. The FCAPS management of the distributed SEDMOS objects is performed to create a reliable, robust and highly available network of collectors and controllers to perform the remote FCAPS monitoring and management of the data storage devices.

[0089] The SEDMOS is customized to collect a specific data. The specific data includes information related to utilization capacity, frequency of usage, priority, hierarchy, utilization pattern of application and storage resources. The information collected by the SEDMOS objects acting as collector are forwarded to the SEDMOS objects acting as

controller through a communication and signaling interface. The data received by the SEDMOS acting as collector are analyzed by the SEDMOS acting as a controller to estimate an appropriate suitable storage resource requirement using the FCAPS methodology and a storage definition tool/application. The collected data are analyzed using the Fault, Configuration, Accounting, Performance and Security (FCAPS) management techniques to optimize the allocation, the delivery, the monitoring and the management of the storage system resources.

[0090] The estimated storage requirements and the services are received and forwarded to a workflow engine to create a workflow to execute the allocation, delivery and the management of the storage resources with respect to the user. An external application is executed on the application server connected to the work flow engine to select a suitable and appropriate application for generating a workflow based on the data collected by the SEDMOS acting as a collector. The SEDMOS acting as controller performs the FCAPS management of the collected data to distribute and align the storage resources with the requested users optimally based on the input business policies and service level agreement executed with the user.

[0091] The signaling enabled work flow engine is connected to the central command and control center through a network to design a workflow to execute a service based on the analysis of the data collected by the SEDMOS. The workflow engine creates a workflow to execute the allocation, the delivery and the management of the storage resources with respect to the user based on the storage requirements and services that are estimated with respect to the data collected by the SEDMOS units. The workflow engine generates a workflow to deliver a required storage related service to the user. The required service is a storage service

which is modeled as a work flow in which the data collectors, the analyzers, the controllers, the administrators and the tools collaborate as a network of distributed objects to provide the desired storage related service.

[0092] The workflow engine creates a workflow by forming two infrastructure layers. One infrastructure layer is created to collect the entire FCAPS data from all users and service resource providers. Another infrastructure layer is created to provide a service to optimize the storage resources with respect to the multiple users based on the collected data and the requirements of the users. The available storage resource infrastructures are optimized end-to-end based on the collected FCAPS data to align the resources to meet the requirements of the users.

[0093] FIG. 1 shows a block diagram of an online remote data storage management system according to one embodiment of the present invention. The remote data storage management system has plurality of SEDMOS 108A, 108B distributed and connected to central control and command centre 102 through internet 104. SEDMOS 108A is programmed to act as a collector and connected to user systems 112,114,116 through an IP network to collect FCAPS management data related to each application and user system 112,114,116. Different user systems 112,114,116 may have different operating systems. The examples of the operating system may be windows operating system112, 114 or a Solaris operating system 116. Another SEDMOS 1O8B is connected to plurality of storage vendors 120,122,124 through a storage area network (SAN) or network attached storage (NAS) or disc attached storage (DAS) 118 to collect the FCAPS data related to different storage systems and storage vendors. Users systems 112,114,116 are connected to storage systems 120,122,124 through storage area network 118.

[0094] The collected data are analyzed at the central control and command centre 102 to estimate an optimum storage system for user 112, 114116 based on the collected FCAPS data automatically. Consultant 106 is connected to the system through internet 104 to monitor the data storage management operations and to intervene to carry our remedial measures during the generation of fault in the distribution of SEDMOS objects or in the collection of data by the SEDMOS objects.

[0095] FIG. 2 shows a functional block diagram of a SEDMOS in a remote data storage management system. SEDMOS 108 is self configured and programmed to act as a collector to acquire Fault, Configuration, Accounting of resource utilization, Performance and Security (FCAPS) data related to the components in the application to storage path from the user. The FCAPS data are related to the user systems and applications. SEDMOS 108 acting as a controller performs Fault 202, Configuration 204, Accounting (of resource utilization) 206, Performance 208 and Security 210 (FCAPS) management processes of the acquired data to estimate the optimum storage resources required for a user based on the output of the FCAPS analysis of the collected FCAPS data.

[0096] FIG. 3 shows a functional block diagram of a work flow engine in a remote data storage management system according to one embodiment of the present invention. SEDMOS objects 108A, 108B are connected to workflow engine 304 through internet to transmit the FCAPS data collected to workflow engine 304 through the central command and control centre. Workflow interpreter 302 is connected to workflow engine 304 to define the output of the FCAPS analysis of the collected FCAPS data. Workflow engine 304 generates a workflow based on the output of workflow interpreter 302 to generate and deliver a storage related service to a user. Workflow engine 304 generates a workflow to deliver a required

service. The required service is a storage service which is modeled as a work flow in which data collectors, analyzers, controllers, administrators 308 and tools 306 to collaborate as a network of distributed objects to provide a storage service.

[0097] FIG. 4 shows a block diagram of a workflow engine in a remote data storage management system according to one embodiment of the present invention.

[0098] The signaling enabled work flow engine 304 (of FIG. 3) is connected to command and a control center through a network to design a workflow to execute a service based on the analysis of collected data by said SEDMOS. Workflow engine 304 (of FIG. 3) creates a workflow to execute the allocation, delivery and the management of the storage resources with respect to the user based on the storage requirements and services that are estimated with respect to the data collected by the SEDMOS units. Workflow engine 304 (of FIG. 3) generates a workflow to deliver a required service. The required service is a storage service which is modeled as a work flow in which data collectors, analyzers, controllers, administrators and monitoring tools 506 to collaborate as a network of distributed objects to provide a storage service.

[0099] Workflow engine 304 (of FIG. 3) creates a workflow by forming two infrastructure layers. One infrastructure layer is created to collect all FCAPS data from all users and service resource providers. Another infrastructure layer is created to provide a service to optimize the storage resources with respect to multiple users based on the collected data and requirements of the users. The available storage resource infrastructures are optimized end-to-end based on the collected FCAPS data to align the resources to meet the requirements of the users.

[00100] Storage definition tool 530 is connected to workflow engine 304 (of

FIG. 3) through application server 514. Storage definition tool 530 is an application to estimate the storage requirements and the services required by the end user based on the data collected through said SEDMOS. The application data stored in XML files 526 is downloaded by a storage definition tool (SDT) importer 528 and stored in the SDT database 532. Storage definition tool 530 is retrieved from SDT database 532 and is forwarded to the application server 514. Application server 514 receives and forwards the estimated storage management information and the services to workflow engine 304 (of FIG. 3).

[00101] External application server 518 is communicatively connected to application server 514 to select a suitable and appropriate application for generating a workflow based on the data collected by the SEDMOS. The external application server includes tool database 520, data collector 524 and data analyzer 522. The data collected by the SEDMOS objects are received by data collector 524 and processed using the data analyzer 522. The analysis result of the data collected by the SEDMOS and data collector 524 is received forwarded from the data analyzer and stored in tool data base 520 for use in application server 514.

[00102] Application server 514 estimates the optimum storage resources required for the user based on the input and collected data such as service level agreement, tools/license data, service request data, data related to user applications and requirement, data related to storage systems, data related to service management process, etc. Application server 514 estimates the optimum storage resources required for the used based on the collected data using the applications selected and retrieved from tool database 520 and SDT database 532 with respect to the data acquired by the SEDMOS objects.

[00103] Application database 516 is connected to workflow engine 304 (of

FIG. 3) and to application server 514 to store the data related to the services, tools, licenses, users and their roles, policy and service requests.

[00104] Work flow engine has work flow definition tool 504, work flow definition database 508, application programming interface (API) 510, service request dispatcher /listener 512 and an administration and monitoring tool 506. Service request dispatcher /listener 512 first receives a service request from the user and forwards the same to application programming interface 510. Administration and monitoring tool 506 is an application which is executed to select a desired storage related service based on the data received from the application server. API 510 generates a work flow definition for delivering the estimated storage related service to the user based on the data received from the service request dispatcher /listener 512 and administration and the monitoring tool 506. The generated work flow definition is stored in workflow definition database 508. Work flow definition tool 504 is an application which is used to generate a work flow to deliver the estimated storage related service to the user based on the work flow definition stored in workflow definition database 508. API 510 forwards the data related to the delivery of the generated storage related service to the user through the service request dispatcher / listener 512.

[00105] The workflow engine creates a workflow by forming two infrastructure layers. One infrastructure layer is created to collect the entire FCAPS data from all users and service resource providers. Another infrastructure layer is created to provide a service to optimize the storage resources with respect to the multiple users based on the collected data and the requirements of the users. The available storage resource infrastructures are optimized end-to-end based on the collected FCAPS data to align the

resources to meet the requirements of the users.

[00106] Thus the various embodiments of the present invention provide a dynamic remote data storage management system and method to deliver storage related services to the users according to the need and requirement of the user. The storage resources are allocated and changed dynamically and automatically by creating two infrastructure layers. One layer is created to allow creation, delivery and assurance of storage services (assessment, management and optimization) that monitor FCAPS data from all devices and elements that align application needs to storage resource allocation and utilization. Second infrastructure layer is created to generate SEDMOS that collect and/or control the data from the devices involved in storage services with high reliability, availability and security. The online remote data storage management system and method enables the remote service creation, FCAPS management, delivery and assurance of storage related services to the user based on request or on demand.

[00107] The remote data storage management system of the present invention enhances the performance of an application and optimizes the usage of storage resources. The system protects the investment, increases the revenue opportunity, enhances the efficiency and the performance of the storage delivery process, improves the access and availability of data at any point of time, simplifies the data storage management process and reduces cost of data storage.

[00108] The foregoing description of the specific embodiments will so fully reveal the general nature of the embodiments herein that others can, by applying current knowledge, readily modify and/or adapt for various applications such specific embodiments without departing from the generic concept, and, therefore, such adaptations and

modifications should and are intended to be comprehended within the meaning and range of equivalents of the disclosed embodiments. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. Therefore, while the embodiments herein have been described in terms of preferred embodiments, those skilled in the art will recognize that the embodiments herein can be practiced with modification within the spirit and scope of the appended claims.

CLAIMS

What is claimed is:

1. A remote data storage management system for detecting, monitoring, managing and optimizing storage systems, comprising:

plurality of signaling enabled distributed and managed object software (SEDMOS) distributed and connected together through a network to a user and to a storage environment to collect and analyze fault, configuration, accounting, performance and security (FCAPS) data;

a signaling enabled work flow engine to design a workflow to execute a service based on the analysis of collected data by said SEDMOS;

a communication and signaling infrastructure to set up communication path between said SEDMOS; and

a centralized command and control center to access and to analyze data collected by said SEDMOS to carry out remote FCAPS management of storage services and resources with respect to users.

2. The system according to claim 1, wherein each said SEDMOS is self configurable, customized and embedded with application software so that one SEDMOS may act as a collector to acquire information related to user storage requirement.

3. The system according to claim 1, wherein each said SEDMOS is self configured, customized and embedded with an application software so that one SEDMOS may act as a controller to collect the acquired data to perform fault, configuration, accounting, performance and security (FCAPS) management of storage resources based on business policies and storage requirement of user.

4. The system according to claim 1, wherein said SEDMOS acting as controller performs FCAPS management of data acquired by said SEDMOS which acting as a data collector, to provide a data storage management service.

5. The system according to claim 1, further comprises a compiler to create said SEDMOS objects.

6. The system according to claim 5, wherein said compiler generates an environment for said FCAPS management.

7. The system according to claim 1, wherein each said SEDMOS module comprises:
a compiler;
a programming language;
a FCAPS environment and signaling enabled FCAPS objects;
a signaling unit; and
a process definition language.

8. The system according to claim 7, wherein said compiler generates a FCAPS environment and signaling enabled FCAPS objects to provide remote analysis, management and optimization of storage resources with the application requirements based on the business policies on application requirements and resource storage alignment.

9. The system according to claim 7, wherein said programming language is embedded in said SEDMOS to make the SEDMOS a collector to acquire the FCAPS data related to the storage resources and applications.

10. The system according to claim 7, wherein said programming language is embedded in said SEDMOS to make the SEDMOS act as a controller to carry out the FCAPS management of storage resources with respect to the application requirements dynamically.

11. The system according to claim 7, wherein said signaling unit enables communication between the distributed SEDMOS.

12. The system according to claim 7, wherein said signaling unit provides communication between SEDMOS and the control centre.

13. The system according to claim 7, wherein said signaling unit performs addressing,

alerting, supervision and mediation processes to ensure that all SEDMOS are operated as programmed in a totally distributed and managed environment.

14. The system according to claim 7, wherein each said SEDMOS has a process definition language to create a process to optimize storage resources with respect to application requirement based on collected data and business policies.

15. The system according to claim 7, wherein said process definition language creates a process to configure a security protocol for data transfer to storage system from user system.

16. The system according to claim 7, wherein said process definition language generates a signaling enabled object interface to create a process to allocate data storage resources optimally with respect to user storage requirements.

17. The system according to claim 1, wherein said workflow engine creates a workflow to execute the allocation, delivery and the management of the storage resources with respect to the user based on the storage requirements and services that are estimated with respect to the data collected by said SEDMOS units.

18. The system according to claim 1, wherein said workflow engine generates a workflow to deliver a required service.

19. The system according to claim 18, wherein the required service is a storage service which is modeled as a work flow in which data collectors, analyzers, controllers, administrators and tools to collaborate as a network of distributed objects to provide a storage service.

20. The system according to claim 1, wherein said workflow engine creates a workflow by forming two infrastructure layers.

21. The system according to claim 20, wherein one of the infrastructure layer is created to collect all said FCAPS data from all users and service resource providers.

22. The system according to claim 20, wherein another infrastructure layer is created to provide a service to optimize the storage resources with respect to multiple users based on the collected data and requirements of the users.

23. The system according to claim 22, wherein the available storage resource infrastructures are optimized end-to-end based on the collected FCAPS data to align the resources to meet the requirements of the users.

24. The system according to claim 1, further comprises a storage definition tool connected to the workflow engine through an application server.

25. The system according to claim 24, wherein said storage definition tool is an

application to estimate the storage requirements and the services required by the end user based on the data collected through said SEDMOS.

26. The system according to claim 24, wherein said application server receives and forwards the estimated storage management information and the services to said workflow engine.

27. The system according to claim 1 further comprises an external application that is executed on said application server to select a suitable and appropriate application for generating a workflow based on the data collected by said SEDMOS.

28. The system according to claim 1 further comprises an application database to store the data related to the services, tools, licenses, users and their roles, policy and service requests.

29. The system according to claim 1, wherein said SEDMOS acting as controller performs said FCAPS management to distribute and align storage resources to requested users optimally based on business policies and service level agreement executed with said user.

30. The system according to claim 1, wherein said SEDMOS has built in FCAPS analysis unit.

31. The system according to claim 1, wherein said SEDMOS has distributed object infrastructure to perform the distribution, monitoring and management of said SEDMOS.

32. The system according to claim 1, wherein each said SEDMOS acting as a collector may be customized to collect a specific data related to user application.

33. The system according to claim 1, wherein the collected data includes information related to utilization capacity, frequency of usage, priority, hierarchy, utilization pattern of application and storage services.

34. The system according to claim 1, wherein said SEDMOS acting as collectors are provided with a specific and narrow set of commands to collect said FCAPS information.

35. The system according to claim 1, wherein said SEDMOS acting as collectors are provided with inherent characteristics to provide their self information to said SEDMOS acting as controllers to distribute, monitor and manage said SEDMOS acting as collectors.

36. The system according to claim 1, wherein said SEDMOS acting as collectors are provided with specific and narrow set of commands to configure specific FCAPS elements.

37. The system according to claim 1, wherein said SEDMOS acting as collectors are connected to the users through internet protocol network.

38. The system according to claim 1, wherein said SEDMOS acting as collectors are connected to the multiple storage vendors through a storage area network.

39. The system according to claim 1, wherein said SEDMOS units have inherent characteristics to furnish required FCAPS data to provide robustness, security, manageability and availability.

40. The system according to claim 1, wherein said SEDMOS acting as collector has a self adjustable capability to correct the faults generated during the deployment of said SEDMOS.

41. The system according to claim 1, wherein said SEDMOS may be customized to communicate with the other SEDMOS units.

42. The system according to claim 1, further comprises a remote control facility connected to said SEDMOS units to provide a manual intervention and control of said SEDMOS.

43. The system according to claim 1, wherein said SEDMOS may be customized to

connect with a remote control facility.

44. The system according to claim 1, wherein said centralized command and control centre allows to discover, analyze, access options to provide a remote control operation to modify storage resource allocation dynamically.

45. A dynamic remote data storage management method using a remote management system including plurality of signaling enabled distributed and managed object software (SEDMOS) communicatively connected to one another through a communication and signaling infrastructure, the method comprising:

communicatively connecting said SEDMOS with user systems to collect information related to applications and system;

configuring said SEDMOS to act as collector and controller;

forwarding collected information to SEDMOS acting as controller through communication and signaling interface;

analysing the data received by said SEDMOS acting as collector in the SEDMOS which is acting as controller, using fault, configuration, accounting, performance and security (FCAPS) management techniques to optimize allocation, delivery, monitoring and management of storage system resources; and

performing FCAPS self management of SEDMOS to create a reliable, robust and highly available network of collectors and controllers to perform remote FCAPS monitoring and management of data storage devices.

46. The method according to claim 45, wherein said information related to the user system and application includes fault, configuration, accounting of resource utilization, performance and security (FCAPS) management information.

47. The method according to claim 45, wherein said SEDMOS is customized to collect a specific data.

48. The method according to claim 47, wherein the specific data includes information related to utilization capacity, frequency of usage, priority, hierarchicy, utilization pattern of application and storage resources.

49. The method according to claim 45, wherein the data collected by said SEDMOS acting as collectors are analyzed in the SEDMOS which is acting as controller to estimate an appropriate suitable storage resource requirement using the FCAPS methodology and a storage definition tool/application.

50. The method according to claim 45, wherein the estimated storage requirements and the services are received and forwarded to a workflow engine to create a workflow to

execute the allocation, delivery and the management of the storage resources with respect to the user.

51. The method according to claim 45, wherein an external application is executed on the application server connected to the work flow engine to select a suitable and appropriate application for generating a workflow based on the data collected by the SEDMOS acting as collector.

52. The method according to claim 45, wherein said SEDMOS acting as controller to perform FCAPS management to distribute and align storage resources to requested users optimally based on business policies and service level agreement executed with said user.

53. The method according to claim 45, wherein said SEDMOS acting as collectors are connected to the user systems through internet protocol network to collect data.

54. The method according to claim 45 wherein said SEDMOS acting as collectors are connected to the storage vendors through storage area net work.

55. The method according to claim 45, wherein user systems are connected to the storage vendor products through storage area network or IP network.

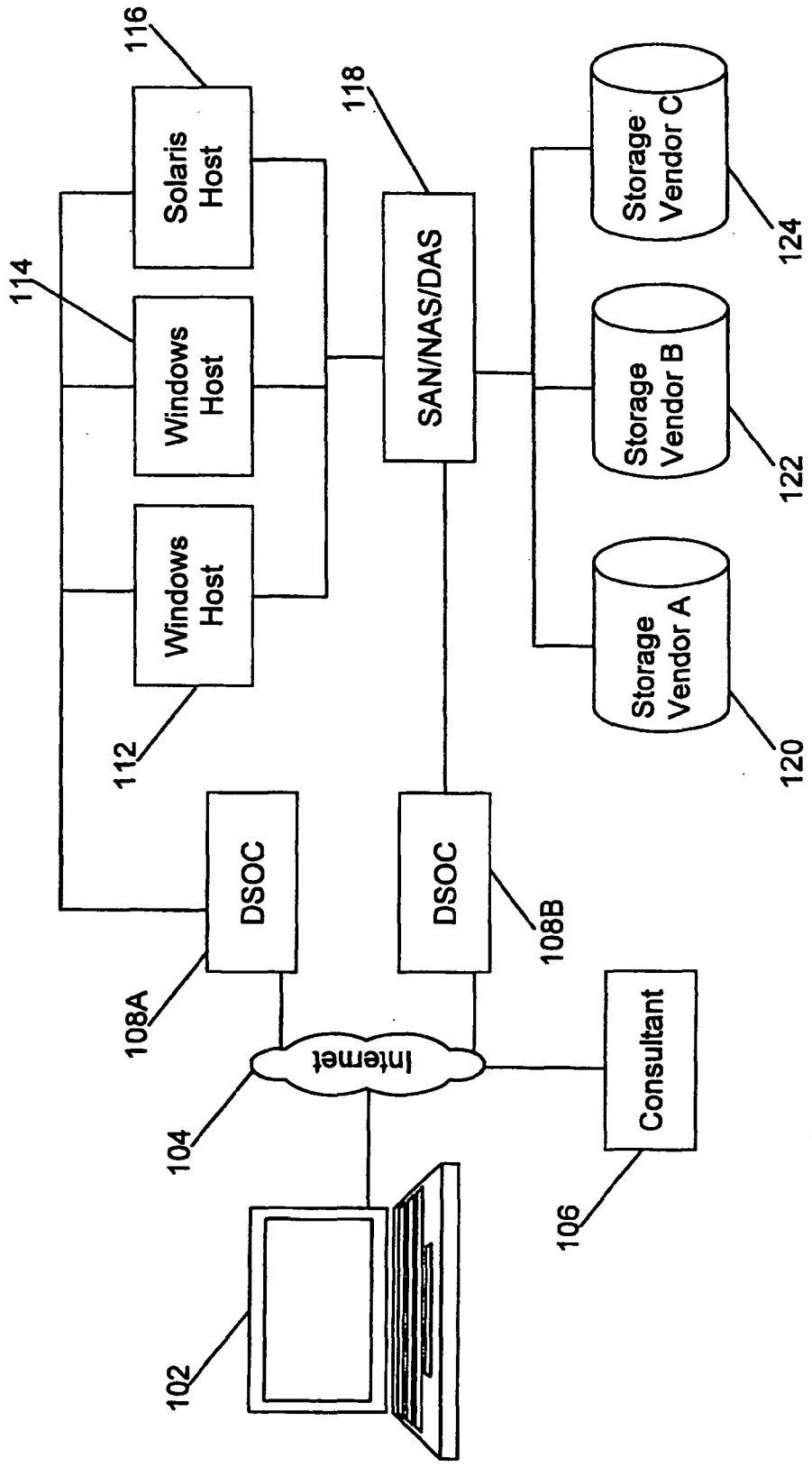
116
Solaris Host
114
Windows Host
Windows Host
112
118
SAN/NAS/DAS
Storage Vendor C
124
Storage Vendor B
122
Storage Vendor A
120
DSOC
108A
DSOC
108B
Internet
104
Consultant
106
102

FIG. 1

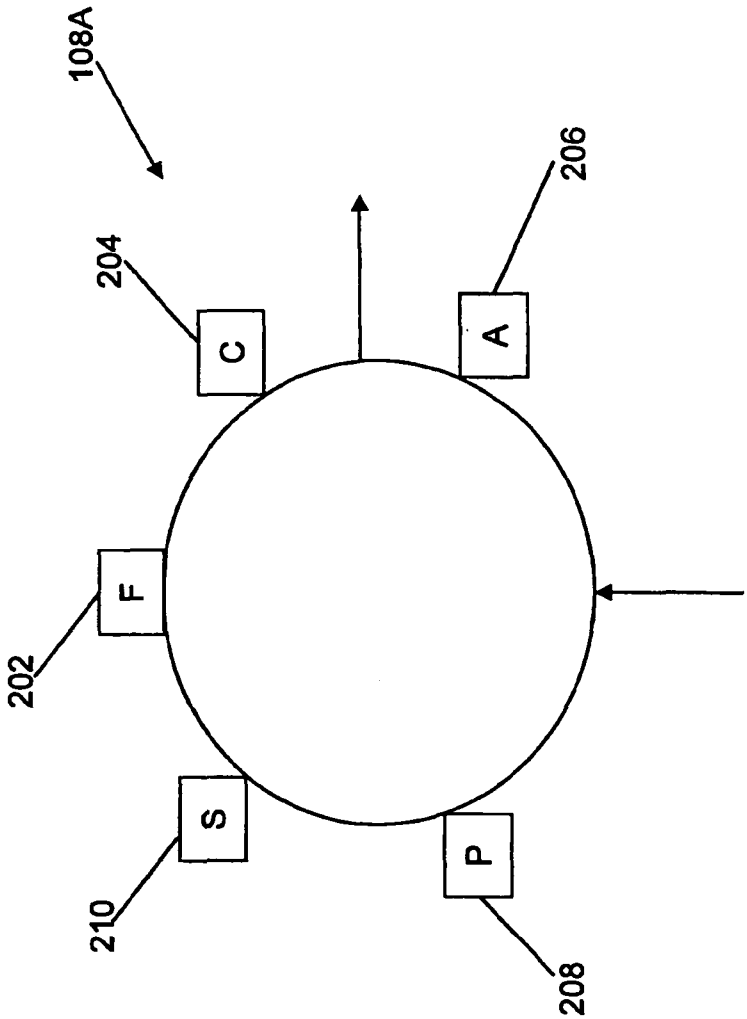

FIG. 2

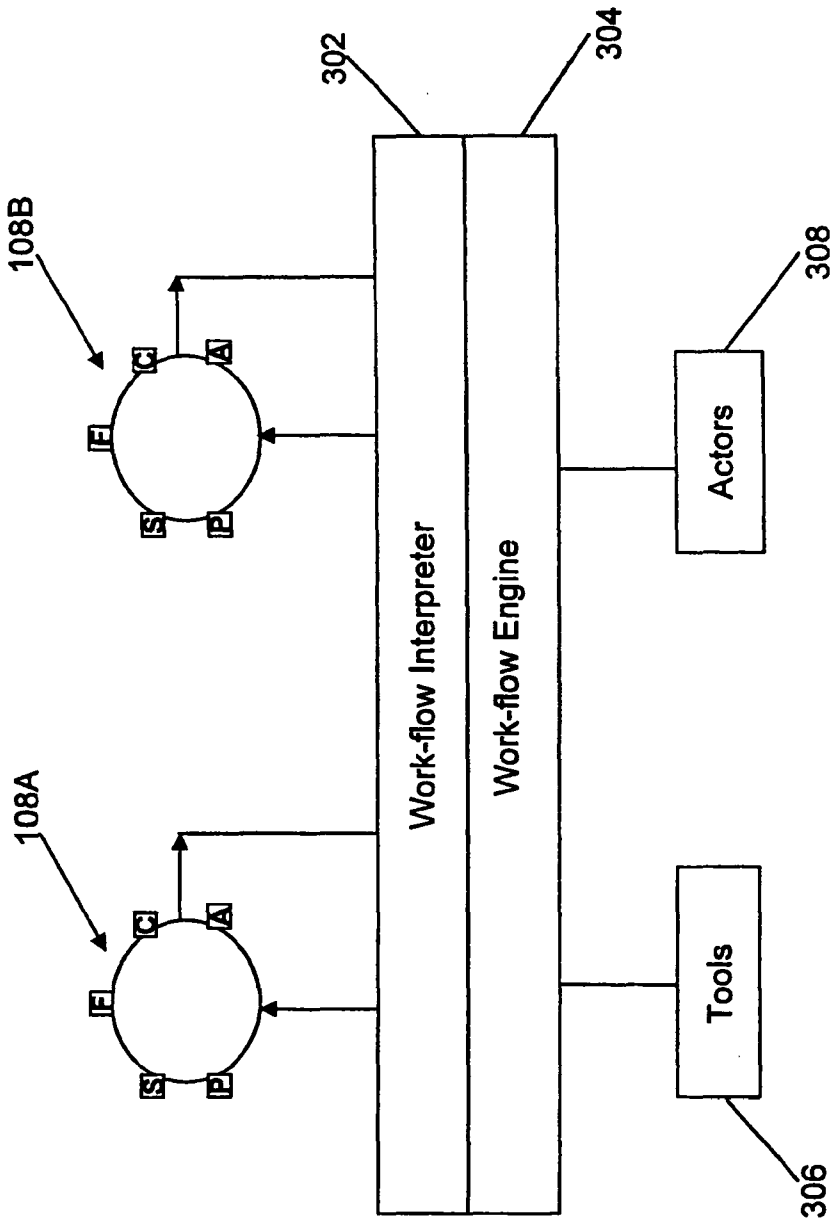
302
304
108B
C
A
F
S
P
308
Actors
Work-flow Interpreter
Work-flow Engine
108A
C
A
F
S
P
Tools
306

FIG. 3

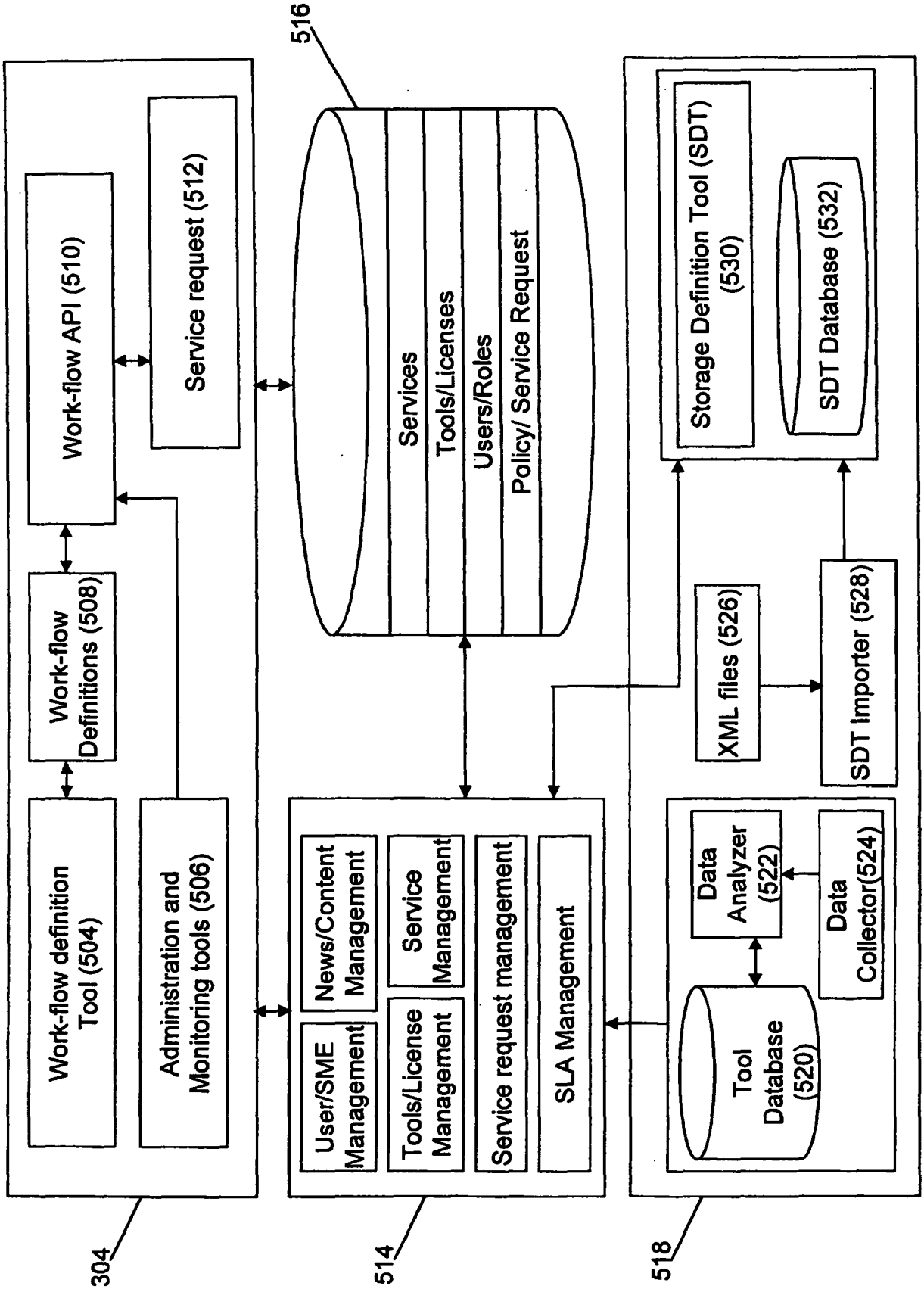
516
Work-flow API (510)
Service request (512)
Work-flow Definitions (508)
Work-flow definition Tool (504)
Administration and Monitoring tools (506)
304
Services
Tools/Licenses
Users/Roles
Policy/ Service Request
User/SME Management
News/Content Management
Tools/License Management
Service Management
Service request management
SLA Management
514
Storage Definition Tool (SDT) (530)
SDT Database (532)
XML files (526)
SDT Importer (528)
Data Analyzer (522)
Data Collector(524)
Tool Database (520)
518

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 07/25189

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G06F 15/167 (2008.04)
USPC - 709/212
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC: 709/212

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 709/203, 211, 213, and 216-219

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Database: USPTO WEST (PGPB, USPT, USOC, EPAB, JPAB) Google
Search terms: remote, connection, access, storage, management, FCAPS, SEDMOS, data, online, network, internet, information, control, dynamic.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2007/0094344 A1 (Miriyala et al.) 26 April 2007 (26.04.2007) (fig. 3A, para [0002]-[0007], [0012]-[0015], [0022]-[0027], [0029] and [0030]-[0040])	1-55
Y	US 2005/0081119 A1 (DiZoglio et al.) 14 April 2005 (14.04.2005) (abstract; fig. 1-3; para [0003]-[0010] and [0041])	1-55
A	US 2006/0253569 A1 (Tamura et al.) 09 November 2006 (09.11.2006) entire document	1-55
A	US 2006/0080399 A1 (Metzger et al.) 13 April 2006 (13.04.2006) entire document	1-55
A	US 2007/0271414 A1 (Nakatani et al.) 22 November 2007 (22.11.2007) entire document	1-55

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 May 2008 (15.05.2008)	29 MAY 2008
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (April 2007)