Prepare Your WebSphere® Web Site for e-business on demand™

An update

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Abstract: This paper introduces how some of IBM's largest customers are starting their transition to on demand computing. It also introduces a limited IBM offering, IBM Server Allocation for WebSphere Application Server, developed by the HVWS group. Finally, the paper identifies what you can do now to improve resource use and ready your e-business to benefit from on demand computing. **This update reflects enhancements to the IBM Server Allocation offering.**

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Introduction

In the last few years, IBM's High-Volume Web Site (HVWS) team has engaged with many large customers to help them understand their workloads, and to design and implement highly scalable e-business infrastructures. The resulting systems operate now to meet the unpredictable workloads common to an e-business. When not meeting peak demands, however, these resulting infrastructures are often left with excess capacity. Excess capacity and the increasing pressure to improve the return on investment are combining to drive businesses to seek new opportunities to use existing resources.

Several leading-edge customers are already working with IBM to optimize their resource use and to consider how emerging on demand technologies and standards can be part of the solution. While the technologies and standards are still under development, there are actions to take now so that when the technologies and standards are available, you'll be ready to transform to on demand computing and benefit from its advantages of managing workloads dynamically, adding applications without adding computing resources, and reducing human intervention.

Among the key technologies for enabling e-business on demand are grid computing and autonomic computing. A *grid* is a collection of distributed computing resources available over a network that appears to an end user or application as one large virtual computing system. A grid can span locations, organizations, machine architectures, and software boundaries offering the promise of providing virtually unlimited power, collaboration, and information access to everyone connected to the grid. One effect of grid computing can be to make network computing more like a utility. You deliver computing power to where you need it only when you need it; you pay for what you use, when you use it.

In addition to grid computing, autonomic computing is moving from concept to reality using Web services and Java™ 2 Enterprise Edition (J2EE) programming constructs. Autonomic computing is an approach to self-managed computing systems with minimal human intervention. Using a combination of grid and autonomic computing, infrastructures will be able to monitor current workload, analyze it versus historical trends and available resources, plan the reallocation of those resources, and automatically execute the movement of workload or resources to maximize computing responsiveness to meet service level objectives; in autonomic terms, this is called the autonomic control loop. This will allow server farms to act as a single *virtual* computing resource.

Having aligned itself around e-business on demand, IBM has new offerings and roadmaps for virtualization technologies that encompass servers, storage, networks, and distributed applications. IBM makes it possible for enterprises to virtualize WebSphere resources today, so that they don't have to wait until tomorrow to realize the business value of the on-demand operating environment. A recent HVWS white paper, *Architecture for Virtualization with WebSphere Application Server, Version 5,* explains how enterprises can use the new and enhanced WebSphere features as the first steps in building and realizing the value of resource virtualization. Enterprises that virtualize will be ready to implement emerging on-demand offerings such as IBM Server Allocation for WebSphere Application Server, a limited offering developed by IBM Research and the HVWS group.

This paper introduces the early work of some of our customers and summarizes the IBM Server Allocation for WebSphere Application Server. The paper identifies what you can do now to improve resource use and ready your e-business to benefit from on demand computing.

Appendix A provides a quick introduction to grid computing and autonomic computing and identifies where you can learn more.

This update introduces the enhancements to IBM Server Allocation, scheduled for limited availability in December 2003. Enhancements include an automatic link to the IBM Tivoli Intelligent ThinkDynamic Orchestrator. Future updates to this paper will expand on current customer projects and describe the lessons learned and best practices emerging from our work, some of which have already been implemented in the enhancements to IBM Server Allocation.

What are leading-edge customers doing?

IBM's largest customers are finding ways to use their excess capacity as a part of their transition to e-business on demand. With help from IBM, they determine which application is the best candidate for their early work. Here are examples of three customers who have begun their transition.

- A leading financial company that offers online trading wants to be able to 'borrow' resources from the high-priority trading application while maintaining its service level agreements (SLA) for trading. The company plans to provide online self-service advice using the excess, available resource. The advice application will run as a lower priority application and be as responsive as it can be with available resources, which will vary based on the needs of the trading application. This application of grid and autonomic computing enables the company to offer their customers more with no additional investment, thereby improving the company's return on investment and improving its ability to compete.

- A large insurance company has the objective of making all servers available to all applications, essentially making their server farm a single virtual computing resource. By doing so, the excess capacity will serve as a 'shock absorber' during peaks in workload. Server grids facilitate workload management by eliminating the need to plan for and manage standby capacity.

- An automobile manufacturer has the vision of allowing a potential customer to design a car online. The new technologies enable such visions without investing in additional capacity.

The limited IBM offering called IBM Server Allocation for WebSphere Application Server addresses these needs using open Web services standards, such as Web Services Description Language (WSDL) and Simple Object Access Protocol (SOAP). The next section introduces the technology.

IBM Server Allocation for WebSphere Application Server

The HVWS team and IBM Research are developing on demand technology using constructs of the autonomic control loop and open Web services standards. IBM Server Allocation for WebSphere Application Server enables WebSphere customers to balance workloads and allocate resources on demand. IBM intends to enhance it as the emerging Open Grid Standard Architecture (OGSA) protocols mature, and make it an integrated component of a future version of the WebSphere Application Server.

IBM Server Allocation allows the customer to run multiple transactional applications and one parallel application in the same grid infrastructure. As the traffic of a higher priority workload increases to such a level that the service level agreement (SLA) objective cannot be met, the system drains the lower priority workloads to other servers in the local or remote grid, to make additional servers available for high priority transactions. When all the servers in the WebSphere server pool are at a high use level serving high priority applications, IBM Server Allocation for WebSphere integrates with IBM Tivoli Intelligent ThinkDynamic Orchestrator to provision additional servers from the data center server pool. As the traffic of the higher priority workloads decreases, the system schedules the lower priority workloads on to the servers where they were previously running.

The primary components of the offering, as shown in Figure 1, are defined to support the goals of the autonomic control loop.

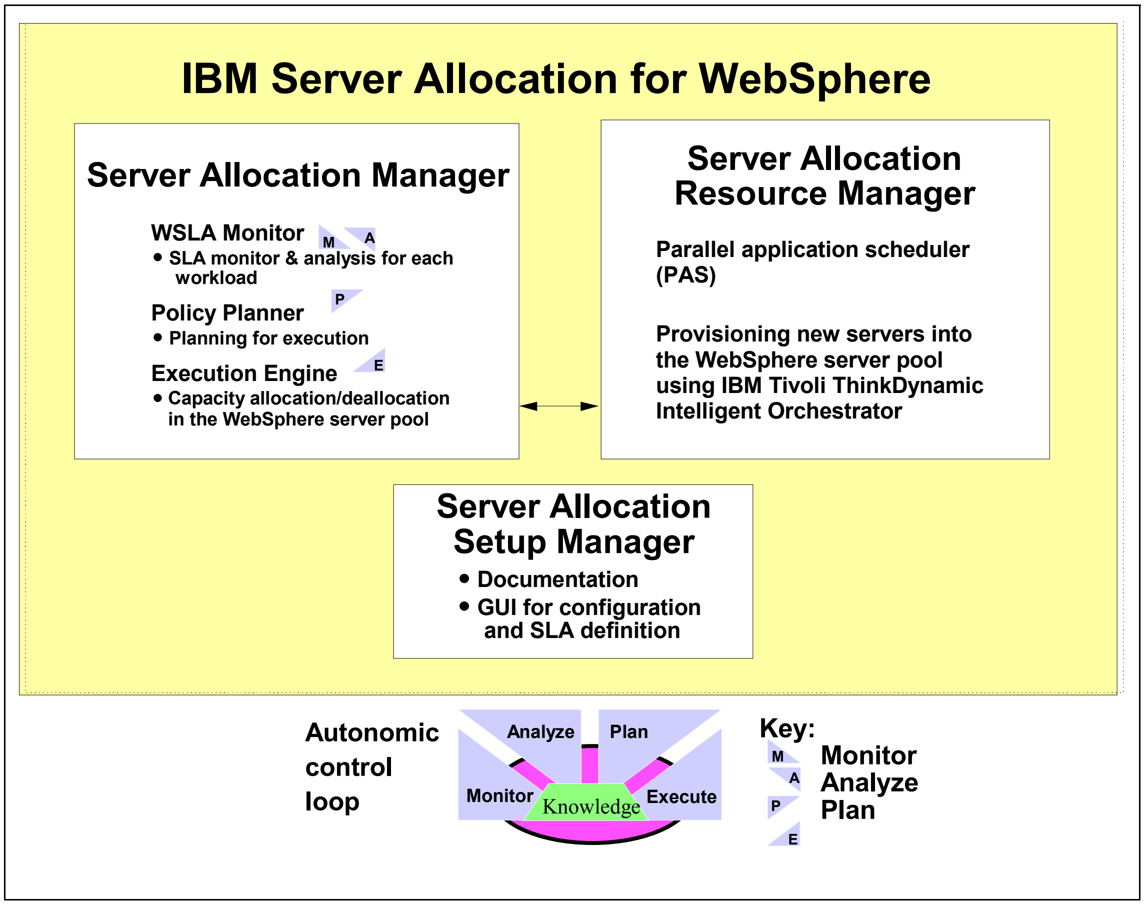

IBM Server Allocation for WebSphere
Server Allocation Manager
WSLA Monitor
M
A
• SLA monitor & analysis for each workload
Policy Planner
P
• Planning for execution
Execution Engine
E
• Capacity allocation/deallocation in the WebSphere server pool
Server Allocation Resource Manager
Parallel application scheduler (PAS)
Provisioning new servers into the WebSphere server pool using IBM Tivoli ThinkDynamic Intelligent Orchestrator
Server Allocation Setup Manager
• Documentation
• GUI for configuration and SLA definition
Autonomic control loop
Analyze
Plan
Monitor
Knowledge
Execute
Key:
M
A
P
E
Monitor
Analyze
Plan

Figure 1. Components of the IBM Server Allocation for WebSphere Application Server

IBM Server Allocation has three major components:

- The *server allocation manager* component is the most sophisticated of the three. It provides the autonomic control loop functions. It contains subcomponents that monitor workloads, analyze data to determine if the workload will continue to meet its service level agreement, and if needed, plans whether resources need to be reallocated, and invokes the server allocation resource manager to reallocate as needed.

- The *server allocation resource manager* allocates resources as needed to meet service level objectives. Its major subcomponent, the parallel application scheduler (PAS), decomposes processing of parallel applications into tasks that can be executed on the available CPUs in parallel, distributes these tasks across the CPUs, and gathers and combines the results. When all the servers in the WebSphere server pool are at capacity, the server allocation resource manager calls IBM Tivoli Intelligent ThinkDynamic Orchestrator to provision a server from the data center server pool into the WebSphere server pool.

- The *server allocation setup manager* facilitates setting service level agreements, and controlling the installation and operation of the Server Allocation components. It is fully integrated with the WebSphere Application Server administration framework.

Server Allocation includes WebSphere Studio Application Developer plug-ins to help in the development of new parallel applications or allow you to modify existing parallel programs that are written in C, Fortran, or other programming languages. Customers can also easily develop Java applications with a new API, so that the application can take advantage of the servers in the WebSphere environment.

An illustration of the server allocation process

This section illustrates the server allocation process. The scenario is an infrastructure for an online brokerage providing two transaction workloads and one parallel workload:

- One transactional workload simulates the common operations of online stock trading. This class of transactional workload represents *business critical* applications.

- The second transaction workload is an account management application through which brokerage customers maintain and view their account information. This application has a lower priority than the stock trading application, but is of higher priority than the parallel application.

- The parallel workload simulates financial analysis services that commercial brokerage houses offer to their customers, such as retirement portfolio analysis. Parallel applications can be broken into units that can be processed in parallel on multiple machines; their processing is typically complex and numerically intensive. The more CPUs made available to a parallel application, the faster the application runs. This class of applications falls in the *value-add* category, contrasted with those in the business critical category.

Our illustration assumes a business rule that processing transactional workloads has higher priority than processing parallel workloads. This business rule implies that whenever there is a surge in traffic to the business critical application, resources are taken away from the value-add application and assigned to the business critical application.
Figure 2 presents a high-level overview of an infrastructure using server allocation.

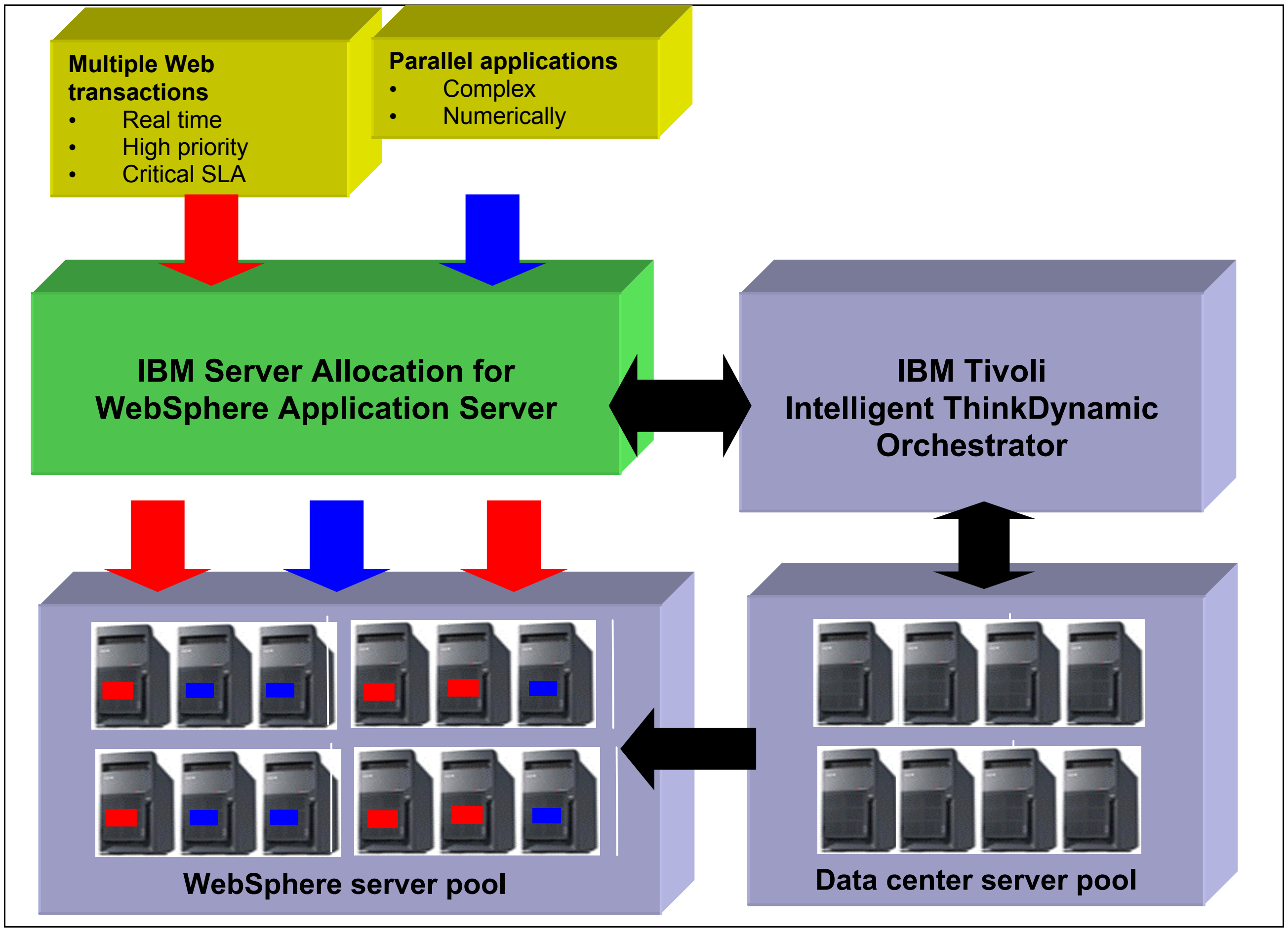
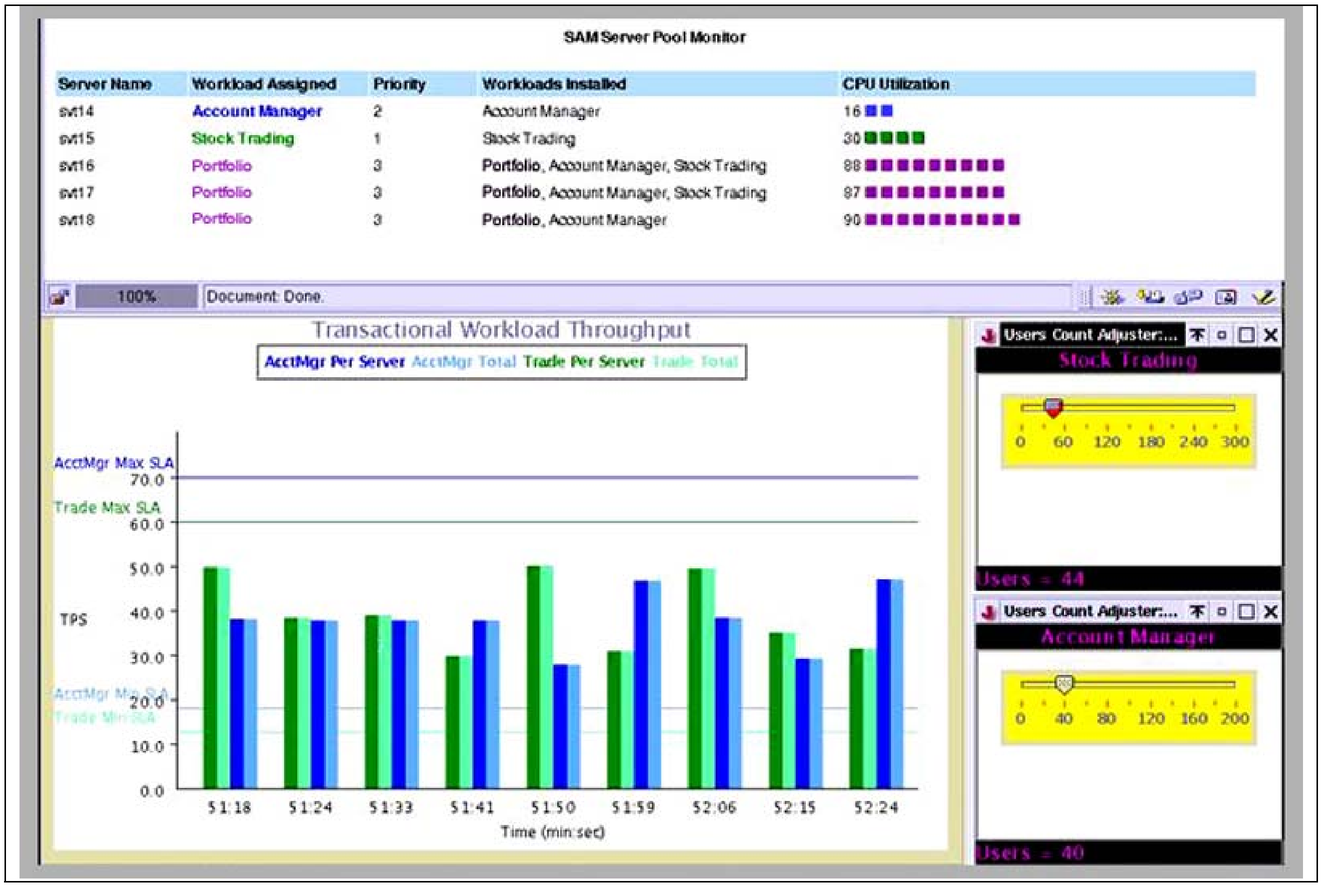

Multiple Web transactions
• Real time
• High priority
• Critical SLA
Parallel applications
• Complex
• Numerically
IBM Server Allocation for WebSphere Application Server
IBM Tivoli Intelligent ThinkDynamic Orchestrator
WebSphere server pool
Data center server pool

Figure 2. Overview of the server allocation demo

Figures 3 through 7 illustrate the server allocation process and how activity might be displayed as it happens.

Figure 3 introduces what we call the *dashboard*. The dashboard indicates how server allocation proceeds through the process of monitoring server use, determining through analysis which servers can no longer meet the SLA requirement, reducing the number of servers assigned to the parallel application, reallocating those servers to the WebSphere Network Dispatcher for use by high priority applications until the load returns to SLA limits, and returning the reallocated servers to the parallel application. When indicated, server allocation can provision an application to a server in the pool or, if necessary, invoke the Tivoli Intelligent ThinkDynamic Orchestrator to provision an additional server from the data center server pool.


SAM Server Pool Monitor

Server Name	Workload Assigned	Priority	Workloads Installed	CPU Utilization
svt14	Account Manager	2	Account Manager	16 🟦🟦
svt15	Stock Trading	1	Stock Trading	30 🟩🟩🟩🟩
svt16	Portfolio	3	Portfolio, Account Manager, Stock Trading	88 🟪🟪🟪🟪🟪🟪🟪🟪🟪
svt17	Portfolio	3	Portfolio, Account Manager, Stock Trading	87 🟪🟪🟪🟪🟪🟪🟪🟪🟪
svt18	Portfolio	3	Portfolio, Account Manager	90 🟪🟪🟪🟪🟪🟪🟪🟪🟪🟪

Figure 3. Server allocation dashboard; servers are well below max SLAs in light traffic

The window labeled `SAM Server Pool Monitor` lists the five servers that comprise the infrastructure. For each server, the window shows what workload(s) is currently assigned, the workload priority, what applications are installed, and current CPU use. Note that Servers 14 and 15 are dedicated to the higher priority workloads, while Server 16, 17, and 18 can run more than one workload. The assignments and metrics are updated periodically as the system responds to traffic and manages the service level requirements for each workload by dynamically allocating and reallocating the servers.

During light traffic:

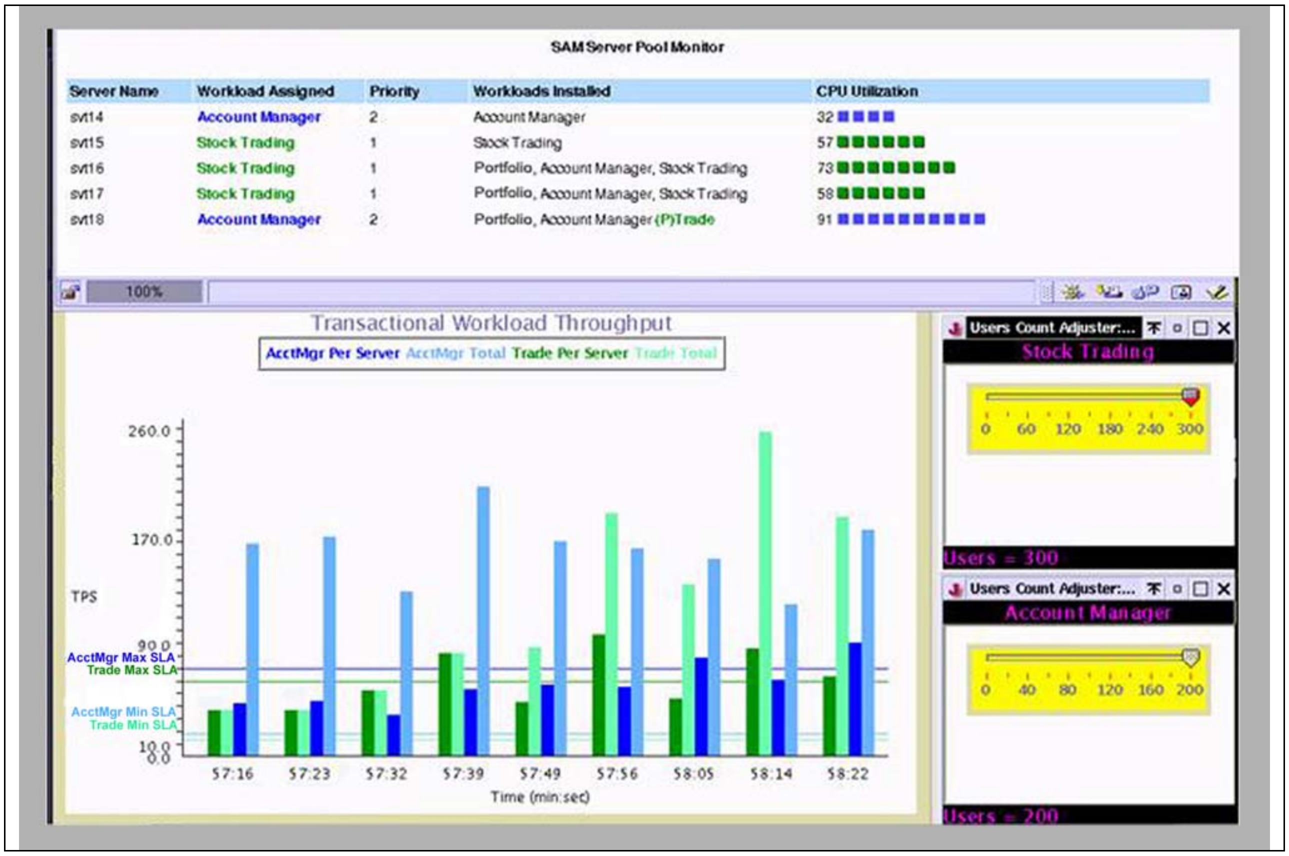
- Server 14 is assigned to the account management workload (blue), the priority 2 application
- Server 15 is assigned to the stock trading workload (green), the priority 1 application
- Servers 16, 17, and 18 are assigned to the portfolio workload (purple), the priority 3 application

The `Transactional Workload Throughput` window shows how the server pool is processing the traffic for each workload. The throughput scale changes as the throughput changes. In the same color as the workload designation above, the horizontal lines represent the minimum and maximum service level for the workload. The vertical bars, again in the same workload color, indicate average throughput (dark bar) and total throughput (light bar).

On the right of the dashboard, there are two driver windows, one for each transactional application. The drivers are used to simulate the workload traffic; traffic is low, around 40 concurrent users per application.

Figure 4 illustrates what happens when the traffic increases. For our illustration, we simulate 300 concurrent users for the Stock Trading workload and 200 for the Account Manager workload. As traffic increases, the available resources are used to such an extent that the service level agreements for both Stock Trading and Account Manager are exceeded. To handle the increased traffic and maintain the SLA, Server Allocation has already assigned Servers 16 and 17 to Stock Trading, making those additional resources available to the high priority application. Account Manager is also missing its SLA.

However, the traffic is such in this snapshot that even the combined resources of Servers 15, 16, and 17 can no longer maintain the SLA. The average Stock Trading throughput still exceeds the maximum SLA threshold. Look at the line for Server 18. The **(P) Trade** indicator in the Workloads Installed column indicates that Server Allocation is provisioning Server 18 with the Stock Trading application to provide the additional resource to process Stock Trading traffic.

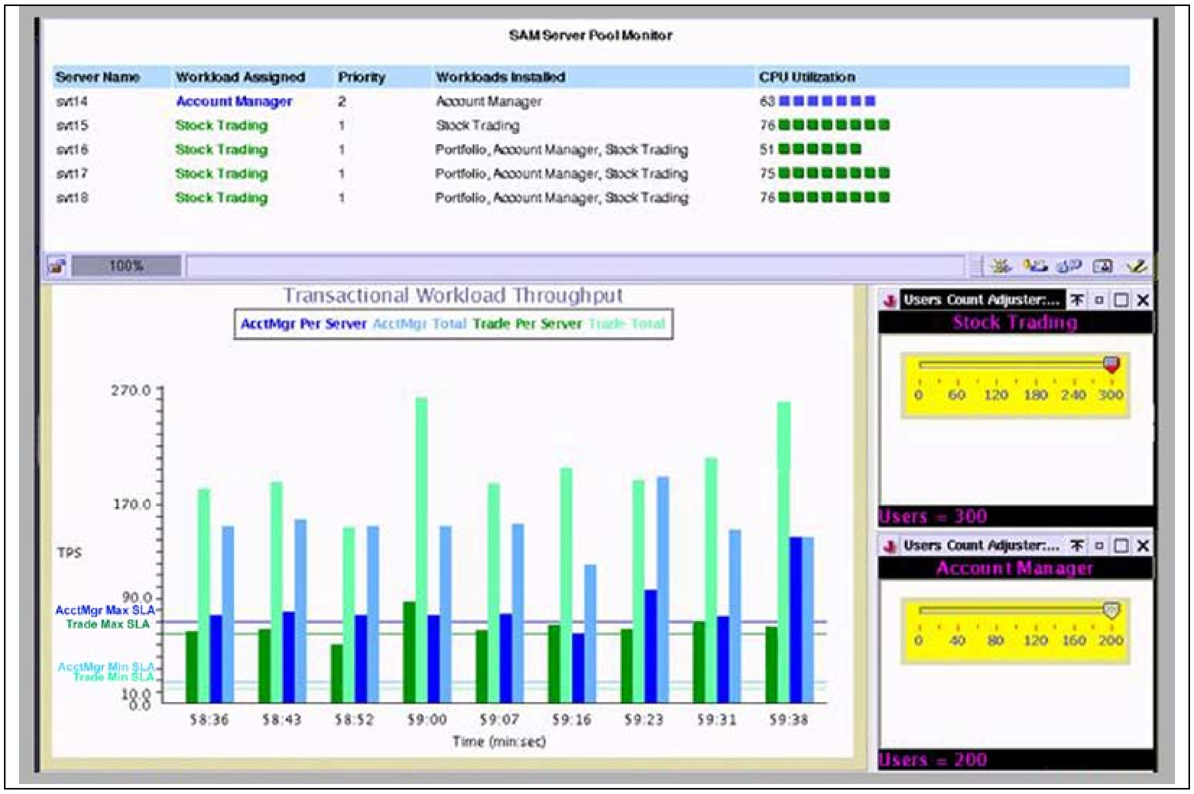


SAM Server Pool Monitor

Server Name	Workload Assigned	Priority	Workloads Installed	CPU Utilization
svt14	Account Manager	2	Account Manager	32 ■■■■
svt15	Stock Trading	1	Stock Trading	57 ■■■■■■
svt16	Stock Trading	1	Portfolio, Account Manager, Stock Trading	73 ■■■■■■■■
svt17	Stock Trading	1	Portfolio, Account Manager, Stock Trading	58 ■■■■■■
svt18	Account Manager	2	Portfolio, Account Manager (P)Trade	91 ■■■■■■■■■■

Figure 4. Max SLAs are exceeded; Server Allocation is about to provision an application to Server 18

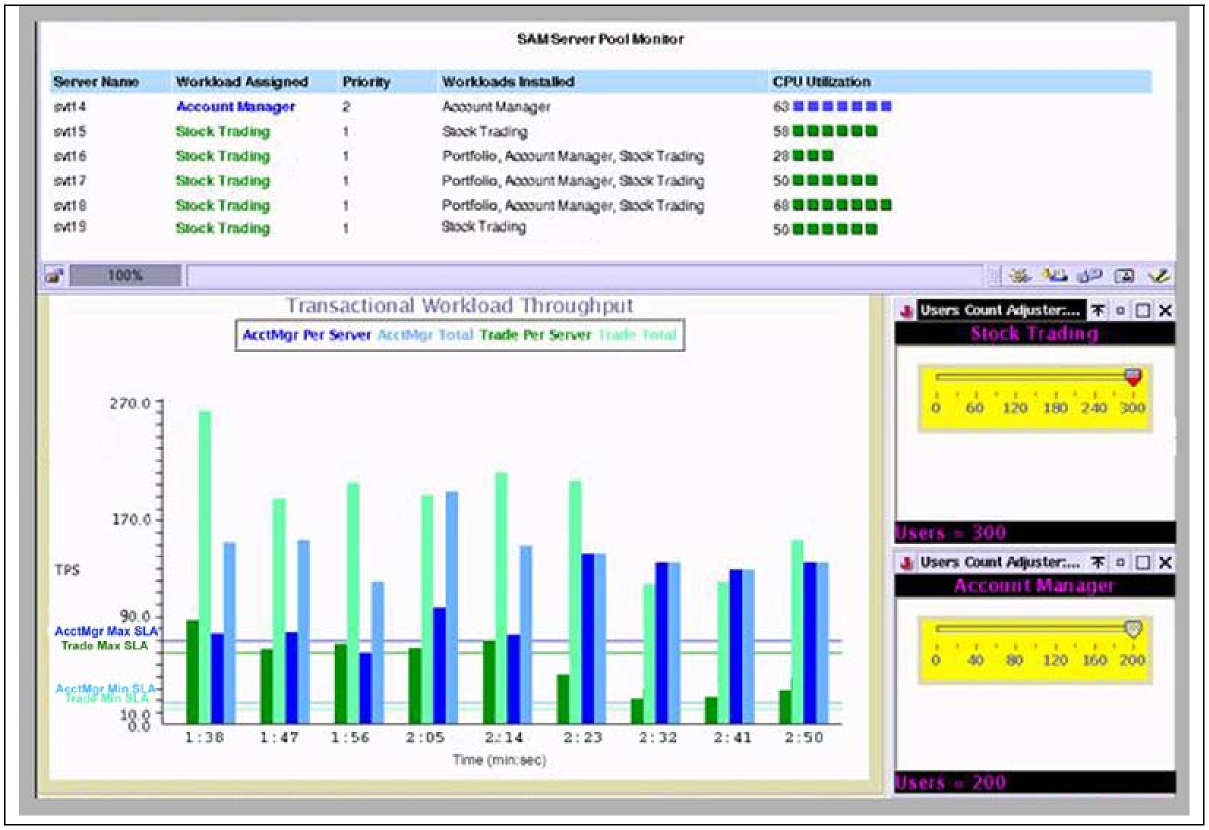
The snapshot in Figure 5 now shows that Servers 15, 16, 17, and 18 are dedicated to Stock Trading. The bar graph for the last timing interval also shows that the SLA is still not being met, even after taking over the last server in the WebSphere server pool. Account Manager continues to miss its SLA. When this situation occurs, Server Allocation invokes the Tivoli Intelligent ThinkDynamic Orchestrator, which provisions another server from the data center pool.


SAM Server Pool Monitor

Server Name	Workload Assigned	Priority	Workloads Installed	CPU Utilization
svt14	Account Manager	2	Account Manager	63
svt15	Stock Trading	1	Stock Trading	76
svt16	Stock Trading	1	Portfolio, Account Manager, Stock Trading	51
svt17	Stock Trading	1	Portfolio, Account Manager, Stock Trading	75
svt18	Stock Trading	1	Portfolio, Account Manager, Stock Trading	76

Figure 5. All installed servers are at capacity; an additional server is needed to maintain the SLA

The snapshot in Figure 6 shows Server 19 has been added to the list of servers supporting the online brokerage. Most importantly, the combined resources of the servers allocated to Stock Trading are now consistently meeting the SLA.


SAM Server Pool Monitor

Server Name	Workload Assigned	Priority	Workloads Installed	CPU Utilization
svt14	Account Manager	2	Account Manager	63 ■■■■■■■
svt15	Stock Trading	1	Stock Trading	58 ■■■■■■
svt16	Stock Trading	1	Portfolio, Account Manager, Stock Trading	28 ■■■
svt17	Stock Trading	1	Portfolio, Account Manager, Stock Trading	50 ■■■■■■
svt18	Stock Trading	1	Portfolio, Account Manager, Stock Trading	68 ■■■■■■■
svt19	Stock Trading	1	Stock Trading	50 ■■■■■■

Figure 6. An additional server is processing stock trades; max SLAs are being maintained

Start now to be ready

It's not too early to begin your transition/transformation to an e-business on demand. You need a strategy to get you from where you are now to where you need to be to reap the benefits of an on demand e-business. Start with learning about the advanced technologies and, as you do, begin to create your strategy. Review the quick introductions to grid and autonomic computing in this paper. Pursue the additional references to learn more. Then think about applying the elements of the autonomic control loop to your strategic planning.

Monitor: The first step is to learn as much as you can about your current workloads. Implement workload monitors so you can better understand workload characteristics and patterns. Application measurements you want to monitor include CPU utilization, response time patterns, and workload peaks and valleys. Tivoli® offers the complete IBM solution for managing the extended WebSphere environment. For precise viewing of performance metrics, users can start with the Tivoli Performance Viewer, a complimentary tool shipped with WebSphere Application Server. For ongoing production monitoring, Tivoli offers the following tools: IBM Tivoli Monitoring for Web Infrastructure (ITMfWI) provides best-practice monitoring of the key elements of WebSphere Application Server, and IBM Tivoli Monitoring for Transaction Performance (ITMfTP) provides a unique perspective of monitoring, that of the end-user.

Analyze: The second step is to analyze your workload measurements. Examine when your peaks occur. Consider what new application could be implemented to use resources available during nonpeaks. For additional information, you can refer to the two HVWS white papers related to performance: *Managing Web Site Performance* and *Design Pages for Performance*.

Plan: The third step is to plan your strategy to move toward on demand processing. Which new application(s) will you implement? On which servers? Do service level agreements need to be modified and/or created? For additional information, you can refer to the two HVWS white papers related to capacity planning: *Planning for Growth* and *High-Volume Web Site Performance Simulator for WebSphere*.

Execute: Finally, you can establish the foundation for your plans. Your IT infrastructure will need to evolve to on demand processing. You can start now making the changes necessary to facilitate your transition:

- Start by installing the monitoring software required for real-time monitoring.
- Review the levels of your software components and upgrade those needed to support your future plans. Consider software based on open standards, such as WebSphere, to facilitate integration.

Take your time creating a methodical approach and you will be ready when appropriate on demand products become available.

IBM has a number of new offerings to help you get ready and get started. To get ready, IBM offers a one and a half day e-business on demand assessment that will help you set the vision, attributes and metrics needed for your e-business on demand transformation. To get started, the IBM Server Allocation for WebSphere Application Server offering described in this paper is available to a limited number of customers. Contact your local IBM sales representative for more information.

Appendix A. Introduction to grid computing and autonomic computing

Grid and autonomic computing are all the buzz. Here's a quick introduction to each. Check out the references for additional information.

Grid computing and Web services standards

A *grid* is a collection of distributed computing resources available over a network that appears to an end user or application as one large virtual computing system. A grid can span locations, organizations, machine architectures, and software boundaries to provide unlimited power, collaboration, and information access to everyone connected to the grid. The effect of grid computing is to make network computing more like a utility. You deliver computing power to where you need it only when you need it; you pay for what you use, when you use it.

Like the Internet, grids started in the scientific community but are now being deployed by business enterprises. Recently, IBM and Globus collaborated to combine open grid protocols and Web services standards, producing the Open Grid Services Architecture (OGSA). OGSA is a distributed interaction and computing architecture that is based around the grid service, enabling interoperability on heterogeneous systems so that different types of systems can communicate and share information. It leverages the emerging Web services standards to define the new Grid Services Definition Language (GSDL) interfaces. Specifically, the Grid service interface is described by GSDL, which defines how to use the service. A new tag `gsdl` has been added to the WSDL definition for grid service description. The UDDI registry and WSIL document are used to locate grid service. The transport protocol SOAP is used to connect data and application for accessing grid service. All services adhere to specified grid service interfaces and behaviors.

Learn more

- Developing Grid computing applications (Article)
- IBM Grid Toolbox (alphaWorks download)
- Installing and configuring the IBM Grid Toolbox (Free tutorial)

Autonomic computing

Autonomic computing was conceived to lessen the spiraling demands for skilled IT resources, reduce complexity and drive computing into a new era that may better exploit its potential to support higher order thinking and decision making. Immediate benefits will include reduced dependence on human intervention to maintain complex systems accompanied by a substantial decrease in costs. Long-term benefits will allow individuals, organizations, and businesses to collaborate on complex problem solving.

Fully autonomic computing systems will be:

- **Self-configuring**: Able to adapt to dynamically changing environments
- **Self-healing**: Able to discover, diagnose, and act to prevent disruptions
- **Self-optimizing**: Able to tune resources and balance workloads to maximize use of IT resources
- **Self-protecting**: Able to anticipate, detect, identify, and protect against attacks

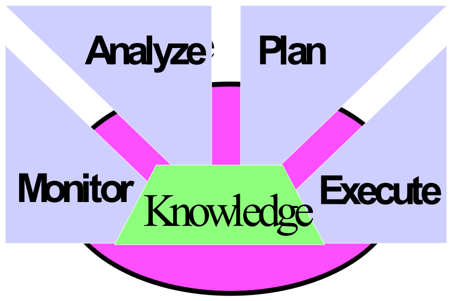
When you implement autonomic systems, you are free to focus on more strategic and higher-level issues. For the business, the core benefits of autonomic computing are improved resiliency, ability to deploy new capabilities more rapidly, and increased return from IT investments.

Autonomic computing capabilities play a critical role in the development of grid computing. Grids can become the most complex computing environments available. Autonomic computing will allow grids to be easily managed and to ensure that they deliver the levels and quality of service demanded by businesses.

Learn more

- Autonomic computing overview and resources (Collection of resources)
- Autonomic computing (Web site)
- Tivoli: Autonomic computing (Web site)
- Administration made easier: Scheduling and automation in DB2 Universal Database (Article, in PDF)

Fundamental to autonomic computing is what is known as the autonomic control loop. The goal is the ability to *monitor* current workload, *analyze* it versus historical trends and existing computing power, *plan* the reallocation of those resources, and *execute* the movement of workload or resources to maximize computing responsiveness to meet service level objectives.



The monitor function implements mechanisms that collect, aggregate, filter, and report details (metrics, topology, etc.) about the resource. The data may be sampled, as with performance metrics, or they may be unsolicited, as with event data. In addition, the monitor function can aggregate data from various external and internal sources, to enable it to produce more meaningful, and higher level, information.

The analyze function implements mechanisms that model complex situations. The analyze function may provide some learning capability, which will in turn allow it to better anticipate future situations. Examples of the analyze function include problem determination, workload forecasting, policy analysis, and event correlation.

The plan function provides a way to coordinate interrelated actions over time. A plan is constructed to achieve a goal, especially, goals related to service level agreements. The goal describes a desired state, for example, browse response time is less than 1.2 seconds. The plan specifies the actions to take and the sequence in which they should be invoked to move from the current state to the desired state. The plan function must also be aware of how long the plans it generates takes to enact and when they have to be completed.

For example, in an automatic order-processing environment, consider a situation where, 15 minutes before the end of the day, more than 2% of the orders initiated on that day have not yet been processed. In this case, the plan function could reasonably decide to provision extra elements of various types in an attempt to ensure that the outstanding orders are processed in time.

Today, this is most frequently embedded in automation scripts. For example, restart sequences are essentially a plan that takes into account the dependency of services on one another. Further, plan information is important in software distribution to properly sequence installs based on prerequisites, corequisites, and exrequisites. There is also plan functionality related to how software is sent between distribution nodes to account for constraints in network bandwidth.

One way to think of a plan is as a workflow. That is, a plan specifies a partial order of actions (for example, start an HTTP process), possibly with entry and exit conditions. This is useful in restart sequences since, for example, one should not restart a servlet until the servlet engine is running, which in turn requires a running JVM.

The execute function interprets plans and interacts with the element effectors to ensure that the appropriate actions occur. For example, if a plan is represented by a workflow, the execute function determines which actions in the workflow graph can be executed (for example, their inputs are satisfied) and then chooses the "best" one to perform. In the case of software distribution, the inputs are install dependencies and "best" may relate to balancing network loads and/or minimizing node down times.

Knowledge: Autonomic computing functions require common knowledge to work in a coordinated way. Examples of this knowledge may include the following:

- State of the managed element and management actions; for example, in the case of a printer, state may be whether it is online or offline; in the case of a Web server, state may be the number of connections currently held
- Dependencies between entities being managed; examples include: service dependencies (for example, an HTTP service requires a name service); install dependencies; and capacity dependencies
- Plans constructed to achieve management goals
- Goals, such as those expressed by service level agreements and policies, such as preferred ways of achieving a goal

References

- *Developing Grid computing applications, Part 1* at www-ibm.com/developerworks/library/ws-grid1/

- *e-business on demand: A developer's roadmap* at www.ibm.com/developerworks/webservices/library/i-ebodov/index.html?dwzone=webservices

- *The Physiology of the Grid* at www.gridforum.org/ogsi-wg/drafts/ogsa_draft2.9_2002-06-22.pdf

- The WebSphere Application Server Performance Web site provides a centralized access to many helpful performance reports, tools and downloads. See www.ibm.com/software/webservers/appserv/performance.html

- *Architecture for Virtualization with WebSphere Application Server, Version 5.*

  See all the IBM High-Volume Web Site white papers at www.ibm.com/websphere/developer/zones/hvws

- Learn about the IBM Tivoli Intelligent ThinkDynamic Orchestrator at www.ibm.com/software/tivoli/products/intell-orch/

  See all the IBM Tivoli products at www.ibm.com/software/tivoli/products/

- IBM Redbooks have additional WebSphere performance information at ibm.com/redbooks.nsf/portals/Websphere

Notices

Trademarks

Contributors

The High-Volume Web Site team is grateful to the major contributors to this article: Ian Brackenbury, Susan Holic, Rahul Jain, Larry Lange, Linda Legregni, Luis Ostdiek, Noshir Wadia, and Peng Ye.