MANAGEMENT BRIEF

ALIGNING PLATFORM AND SERVICE MANAGEMENT

with IBM Systems Director and Tivoli Solutions

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Infrastructure Economics

What is the business case for enterprise infrastructure management? Most organizations adopt segmented approaches. For example, investments are justified by the benefits of improved storage or network management, or more effective data center operations, or better security or business continuity arrangements. Initiatives typically focus on specific functions or platforms and tend to be incremental.

Strategies based on incremental approaches assume, however, that existing infrastructures are largely efficient. This may appear to be the case. The situation does not deteriorate seriously from year to year.

This view, however, may be based on a fundamental misperception. In many organizations, infrastructure inefficiencies have been building up for decades. Because the process has been gradual, it has often not been visible in annual planning and budgeting cycles. High levels of infrastructure spending have become regarded as "normal."

During 2008, almost 63 percent of IT expenditure by the average Fortune 1000 corporation will be on infrastructure resources such as servers, storage, middleware, and networks. If, however, infrastructure efficiency can be materially improved, there is an opportunity for major changes in overall IT cost structures and effectiveness.

In the average Fortune 1000 corporation, an effective enterprise management strategy employing such components as IBM Systems Director 6.1 and IBM Tivoli offerings could potentially reduce infrastructure costs by around 15 percent through improved capacity utilization, reduced administrative costs, and other effects. This would represent a more than nine percent reduction in overall IT expenditure.

This report is about this opportunity. Specifically, it looks at the role that IBM Systems Director 6.1 and Tivoli offerings may play in achieving such gains. Combined, these represent a unified solution set capable of managing the full range of IBM as well as non-IBM infrastructure resources in a manner that both increases efficiency and improves the alignment of IT resources with business goals and priorities.

The Black Hole

IBM Systems Director 6.1 deals with the management of distributed servers – which means that it deals with what is, for any organization attempting to implement effective enterprise management, one of the IT universe's largest "black holes."

Distributed servers represent the greatest source of infrastructure inefficiency. They are also, in terms of operating status, configurations, utilization levels, energy consumption, and other variables, the most poorly tracked of infrastructure resources. Without corrective action, this situation will deteriorate further.

Organizations must deal with two trends – one long-established, and one emerging. These are:

1. ***Physical server proliferation***. The effects of this trend have been widely documented. Among x86 server bases, capacity utilization is the lowest, and downtime the highest of any major IT resource. Overall capacity utilization is typically in the 5 percent to 25 percent range, and most industry estimates put the norm at around 15 percent.

   Numbers of administrators are higher – by wide margins – than for other server platforms, or for storage systems and networks. In most organizations, use of Windows and Linux management tools is at best uneven, and inefficient manual practices are widespread. The result is a level of inefficiency that would not be tolerated in any other area of the business.

For users concerned about rising data center energy consumption, it should also be noted that x86 servers typically account for 50 to 60 percent of overall energy consumption by IT equipment.

As the energy used by data center power, cooling, and air conditioning systems is generally proportional to that of IT equipment, this means that in practice x86 servers are the largest driver of overall energy consumption by IT organizations. Even small reductions in x86 server power usage will have positive "ripple effects" across the entire data center infrastructure.

Although these effects are most visible for x86 server bases, efficiency levels and cost structures are often similar in organizations that have deployed large numbers of small UNIX servers.

2. ***Virtual server proliferation***. Growing adoption of VMware, along with Xen and Microsoft virtualization enablers, has begun to slow growth in x86 physical server bases.

   The benefits of server virtualization in enabling consolidation and improving the speed and flexibility of server provisioning became apparent at an early stage. As organizations have moved beyond pilot projects to larger-scale deployments, however, they have discovered that virtualization creates new management challenges.

   One common experience in deploying VMware ESX, for example, has been that an entire new layer of software architecture is created. Organizations must deal with new structures such as VMware resource pools and clusters, as well as with physical servers and operating systems.

   This more complex environment makes even basic discovery more difficult. Monitoring of virtual servers poses challenges that are significantly different to those of the physical server world. Change and configuration management tools and processes must deal with virtual images that can be easily created, altered, and moved between platforms.

   Virtualized environments, moreover, create new forms of availability and security exposure. Management of shared storage resources, along with software updates, backup and recovery, and other tasks may also become more exacting.

From a server management perspective, these are unwelcome developments. Organizations must increasingly deal with mixed physical and virtual server environments. Challenges are compounded by the fact that virtual server bases are growing rapidly.

To put this in perspective, by the end of 2008, a typical U.S. Fortune 1000 corporation will have slightly more than 4,200 physical x86 servers. If current trends continue, by the end of 2013, the same organization will contain more than 6,000 physical x86 servers – growth in physical bases is expected to continue, albeit at a slower rate – and between 5,000 and 10,000 virtual x86 servers.

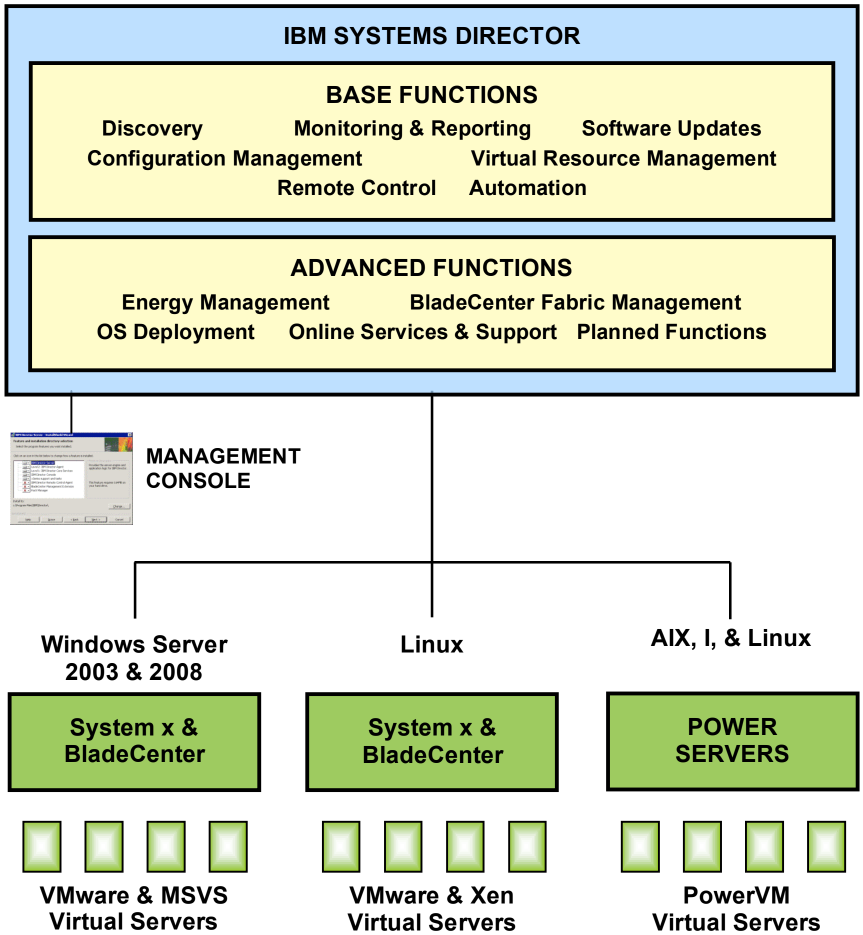
How will such environments be managed? For IBM server users, the product set built around Systems Director 6.1 offers the obvious solution.

Systems Director 6.1 provides a core set of functions, including discovery, monitoring and reporting, configuration and software update management, remote control, and automation. A compatible set of IBM offerings integrate advanced functions such as energy management, operating system deployment, management of BladeCenter fabrics, and online service and support.

These functions are supported transparently for Windows and Linux operating systems, along with VMware, Microsoft Virtual Server (MSVS), and Xen virtual resources on the principal IBM x86 physical server platforms – IBM System x and IBM BladeCenter. Support also extends to IBM AIX, IBM i, and Linux operating systems and PowerVM virtual resources on the company's Power servers.

These capabilities enable unified management of physical and virtual resources on all platforms through a common management console and browser-based administrator interface. The resulting environment is illustrated in figure 1.

Figure 1
Systems Director 6.1 Environment



Systems Director 6.1 also allows for integration of two other sets of resources under a common management umbrella: (1) z/VM Linux guests hosted on IBM System z mainframes; and (2) distributed disk storage, including the company's DS3000, DS4000, and DS6000 disk systems, RAID controllers, the SAN Volume Controller (SVC) virtualization solution, and IBM and third-party SAN devices.

Enterprise Integration

For more than a decade, there has been a growing recognition that all components of organizational IT environments have grown more complex and interdependent. It has become clear that full range of IT resources must be managed more effectively at the enterprise level.

Solutions designed to meet these challenges have been available for more than a decade from vendors such as BMC Software (Patrol), Computer Associates (Unicenter), Hewlett-Packard (OpenView), and IBM (Tivoli). Their implementation, however, has been an uneven process.

To some extent, this has been because enterprise management solutions are themselves often technically complex. Deployment challenges have been magnified by the diversity of applications, platforms, and technologies in enterprise IT environments, and by the rate of change in these.

A more important factor, however, has been that most IT organizations are not structured to deal with management challenges at the enterprise level. Deployments tend to focus on specific disciplines – e.g., data center operations, network management, storage management, security management, and financial management – and specific sets of IT resources.

There has been some convergence around processes that set and administer service level agreements (SLAs). Typically, however, silo-based IT structures have resulted in silo-based management systems.

There are, nevertheless, some indications that this situation is beginning to change. Three key change agents have entered the picture:

1. ***Server virtualization***. In most organizations, the depth and effectiveness of management systems varies widely between platforms. Mainframe management tools and processes have typically been in place for decades, and high-end UNIX server and storage environments now generally equal these in sophistication and effectiveness.

   Apart from a minority of platforms supporting business-critical systems, however, management of x86 and small UNIX server bases is a great deal less advanced. Concentration of servers in data center racks has done little to address fundamental inefficiencies.

   This situation might continue indefinitely were it not for the growth of server virtualization. Rapid adoption of VMware and other tools represents a powerful change agent. Organizations are faced with the need to create management infrastructures at an early stage, before large-scale proliferation occurs.

   Although VMware and others offer management tools for virtualized environments, these often lack scale and functionality, and they do not address the broader challenges of managing mixed physical and virtual resources. Reliance upon them could create "islands" of control that would make it more, rather than less difficult to integrate management systems and processes across large organization x86 server bases.

   Systems Director 6.1 offers the means of putting in place an effective management infrastructure for x86 as well as other IBM servers that can handle the growth of virtualization in a non-disruptive and cost-effective manner. Potential problems can be averted at an early stage.

   There is also an opportunity to break the longstanding industry impasse between enterprise and server management tools.

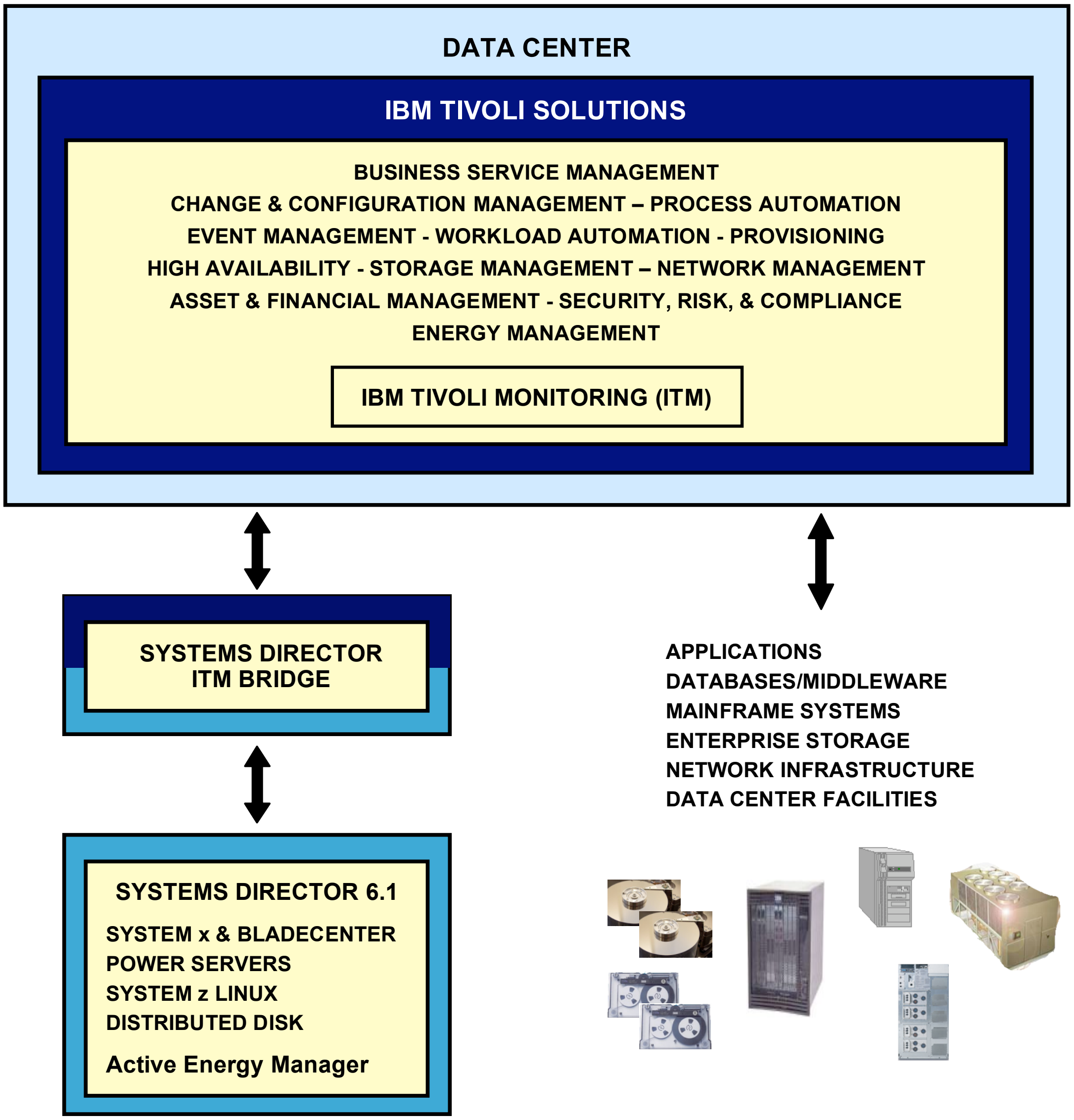
   In the past, organizations have been faced with a choice of two very different sets of tools. Enterprise management suites have offered high-level functionality, but their complexity and cost has prevented widespread adoption to manage small server bases.

   At the other end of the spectrum, bundled management packages, such as Dell OpenManage, Hewlett-Packard Insight Control Environment (ICE), and IBM Director, offered lower-cost but more basic options for x86 server bases. Interfaces between these and enterprise management solutions were – and, in most cases, still are – limited to simple forms of data exchange.

   With Systems Director 6.1, however, IBM has begun to realize a more substantive integration of these types of solution. Systems Director 6.1 addresses the server level at comparatively low cost (basic functions are bundled free of charge with IBM servers, and advanced function modules are inexpensive), while sharing common agents and management processes with Tivoli solutions.

This approach, which is illustrated in figure 2, integrates server and enterprise management levels more effectively than any competitive solution.

Figure 2
Integration of Systems Director 6.1 and IBM Tivoli Solutions



The key link between these levels is through a bridge between Systems Director 6.1 and IBM Tivoli Monitoring (ITM) that allows the latter to collect and aggregate a broad range of server hardware metrics. These may then be integrated with operating system, middleware, application, and network metrics with other data to provide a unified view of infrastructure resources.

Monitoring, along with event management, performance and capacity management, reporting and other tasks, may then be undertaken in a coordinated manner across all resources. This yields significant efficiency improvements, and materially reduces the time and difficulty required to identify, diagnose, and resolve problems.

Data collected from Systems Director 6.1 may also be consolidated and combined with other metrics in the Tivoli Data Warehouse for analytical and planning purposes.

2. ***Energy management***. Data center energy consumption has engaged the attention of the highest levels of business management. Pressures to demonstrate quantifiable gains in energy conservation and environmental responsibility have reinforced economic considerations to make this an important new change agent.

   Organizations cannot effectively reduce data center energy usage unless they address the single largest consumer – their small server bases. One implication is that energy conservation may play a major role in driving broader deployments of server management tools.

   Energy management, to a much greater extent than for any competitor, is a central component of IBM management solutions and strategy.

   At the server level, an extensive set of energy monitoring, reporting, and control functions is built into IBM Active Energy Manager, which forms an integral part of the Systems Director 6.1 environment and supports all of the company's distributed server and storage platforms.

   At the enterprise level, IBM Tivoli Monitoring can be extended through ITM for Energy Management to monitor energy consumption. ITM for Energy Management, which integrates Systems Director and Active Energy Manager, allows for collection and aggregation of data from servers as well as other infrastructure resources in the same manner as for other metrics.

   Monitoring, collection and analysis of data, and management of energy-related processes may thus be integrated across a wide range of IBM as well as non-IBM platforms.

3. ***Business alignment***. There is growing interest in the subject of IT governance. This has been reflected in growing adoption of service management frameworks such as IT Infrastructure Library (ITIL) and Control Objectives for Information and Related Technology (COBIT), as well as in broader debates as to how IT may be better aligned with business goals and strategies.

   The argument that there should be closer alignment has gained increasing traction among business executives, to the extent that it may also play a major role in encouraging adoption of more aggressive cross-functional approaches to enterprise management.

   This argument is addressed in IBM Tivoli strategy. The entire portfolio of Tivoli solutions is aligned with and supports the delivery of IT service to meet business objectives.

   In the IBM approach, which is illustrated in figure 3, the highest level of the Tivoli solution portfolio consists of Business Service Management applications. These deal with definition and monitoring of service level agreements as well as with broader business-driven processes of IT goal-setting, performance measurement, and service strategy development.

   Figure 3 shows only the principal Tivoli offerings. Overall, IBM markets more than 450 major Tivoli-branded products that cover a wide range of applications, management functions, and platforms. The Tivoli product line is discussed in more detail in the Management Solutions section of this report.

Although a number of other vendors offer enterprise management suites, none rivals the breadth or degree of integration of the Tivoli solution portfolio. Many of the components of this portfolio are recognized industry leaders in their respective management disciplines and areas of functionality.

The Tivoli portfolio includes IBM internally developed applications, as well as "best of breed" solutions obtained through more than 40 acquisitions of and investments in leading-edge specialist suppliers.

IBM is believed to have spent more than $3 billion on Tivoli-related acquisitions, and at least the same amount for internal development and integration; i.e., the Tivoli portfolio represents an overall investment of more than $6 billion. No other enterprise management vendor has committed resources of this magnitude to the development of its solution portfolio.

Figure 3
IBM Tivoli Solution Portfolio

ENTERPRISE MANAGEMENT
IBM Tivoli & services solutions

BUSINESS SERVICE MANAGEMENT
Business Service Manager · Service Request Manager · Service Level Advisor · OMNIbus · Data Integration Tools

CHANGE & CONFIGURATION MANAGEMENT
Change & Configuration Management Database · Application Dependency Discovery Manager

PROCESS AUTOMATION
Availability Process Manager · Business Continuity Process Manager · Capacity Process Manager
Change Process Manager · Release Process Manager · Storage Process Manager

MONITORING & EVENT MANAGEMENT
IBM Tivoli Monitoring (ITM) · Composite Application Manager · Performance Analyzer

WORKLOAD AUTOMATION
Enterprise Workload Manager
Dynamic Workload Broker
Workload Scheduler

PROVISIONING
Provisioning Manager
Provisioning Manager for OS
Provisioning Manager for Software
Intelligent Orchestrator

HIGH AVAILABILITY
System Automation for Multiplatforms
System Automation for z/OS

STORAGE MANAGEMENT
Archive Manager
Storage Manager
TotalStorage Productivity Center
SAN Volume Controller

NETWORK MANAGEMENT

IP Networks
Network Manager
- IP Edition
- Transmission Edition

Mainframe Networks
NetView for z/OS
NetView Distribution Manager
NetView Performance Monitor

ASSET & FINANCIAL MANAGEMENT
Usage & Accounting Manager · License Compliance Manager · Asset Management for IT
License Metric Tool · License Compliance Manager for z/OS · Maximo Suite

SECURITY, RISK & COMPLIANCE
Access Manager · Federated Identity Manager · Key Lifecycle Manager
Identity Manager · Directory Server · Compliance Insight Manager
Identity Manager for z/OS · Directory Integrator · zSecure Suite

DATA CENTER TRANSFORMATION
Energy Management
ITM for Energy Management

Internally developed as well as externally-sourced applications implement a common data model, and have been equipped by IBM with industry-leading automation capabilities. The company has also engineered end-to-end process structures that allow for high levels of integration across conventional management "silos." The whole is a great deal more than the sum of the parts.

Conclusions: Saving the Lobster

There is an old saying that a lobster can be boiled without realizing it. As the temperature increases only one degree at a time, the lobster does not realize what is occurring until it is too late. Arguably, something similar has occurred in the IT world.

The growth of infrastructure inefficiency has been a gradual process. As organizations moved away from traditional centralized computing models in the 1980s and 1990s, IT infrastructures became dominated by small servers. The impact of the Internet and intranets and the growing complexity of software architectures and applications in the late 1990s and 2000s reinforced this trend.

Server consolidation initiatives and more widespread use of management tools have led to some improvements. In most organizations, however, server bases remain fragmented, and their use is characterized by levels of inefficiency that would not be tolerated in other areas of the business.

VMware and other x86 server virtualization enablers offer the potential for further consolidation, but generate new manageability and service quality challenges. If their deployment is not accompanied by the creation of effective server management infrastructures, they may both replicate and exacerbate the problems caused by physical server proliferation.

This situation, however, does not have to be addressed in a reactive manner. Growth of server virtualization, as well as pressures for improved energy management and increased business alignment, may act as catalysts for more far-reaching changes.

The next major IT breakthrough may not be another "hot" new technology or a new type of "killer" application. It may instead be the creation of infrastructure efficiency in a manner that enables a significantly larger proportion of IT resources to be channeled into investments that contribute directly and materially to the realization of business value.

What might the effects be in any organization if infrastructure expenditure could be reduced by, say, 10 percent or even 25 percent, and if these funds became available for new, high-value application deployment projects? Major gains in business agility and competitiveness might be achieved.

The tools and technologies to realize such gains are becoming available. What is needed now is the ability to recognize and act upon the opportunities they represent.

INFRASTRUCTURE ECONOMICS

Costs and Benefits

One of the greatest challenges facing any management initiative is cost justification. Even when tools are offered by vendors for no charge, or are inexpensive (which is the case for Systems Director 6.1 core and advanced modules respectively), investments in time and effort may be required to replace existing software, establish new practices, and retrain administrators.

Costs of enterprise-level management tools are typically higher, and investments in time and effort to deploy them tend to be larger. In both cases, it is thus necessary to understand and articulate two key variables: (1) the costs of failing to improve efficiency; and (2) the potential benefits in cost reduction and other areas if efficiency can be improved.

This section addresses these issues from three perspectives:

1. The impact of infrastructure inefficiency on enterprise-level IT expenditures, and the savings that may be realized if inefficiency can be materially reduced;
2. The challenges posed by proliferation of conventional servers and by new server technologies such as blades and virtualization; and
3. The effects of growing energy consumption and rising energy costs on data center cost structures.

The potential role of Systems Director 6.1 and Tivoli solutions in meeting these challenges is discussed in this section. The capabilities of these solutions are discussed in the following section.

Enterprise Level

Segmenting IT Expenditure

The business contribution of IT expenditure has been the subject of growing debate since the late 1990s. Business executives, as well as consultants and analysts, have long been frustrated by their inability to relate overall IT expenditure to business performance. Some have argued that "IT doesn't matter" and that resources should be channeled into other areas of the business that offer potentially higher returns.

More usefully, a number of researchers have suggested that the issue is not the overall level of IT expenditure, but rather how it is distributed.

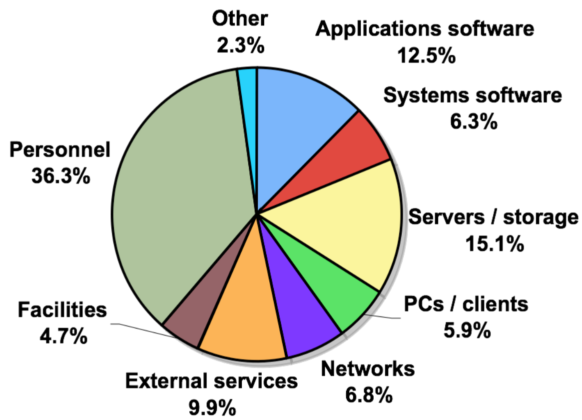
One way of looking at the subject is to distinguish between expenditure on applications – which are the direct source of business value – and the infrastructures that support them. Users interact with, and business processes are enabled by applications. Underlying server, storage, middleware, and network resources are merely the delivery mechanisms for these. Their contribution to business value is indirect.

A strong case can be made that expenditures on underlying infrastructures have come to dominate IT budgets. This has occurred to the extent that investment in new application capabilities, in many organizations, has become entirely inadequate.

This trend has been obscured by the way in which organizations segment IT expenditure. Conventional categories such as hardware, systems and applications software, networks, external services, personnel, and facilities may be useful for accounting purposes. But they do not correlate spending with the delivery of business value.

The implications may be simply illustrated. Figure 4 shows a breakdown of projected 2008 IT expenditure by Fortune 1000 companies using conventional categories.

Figure 4
IT Expenditure by Fortune 1000 Companies in 2008 (Projected): Conventional Breakdown

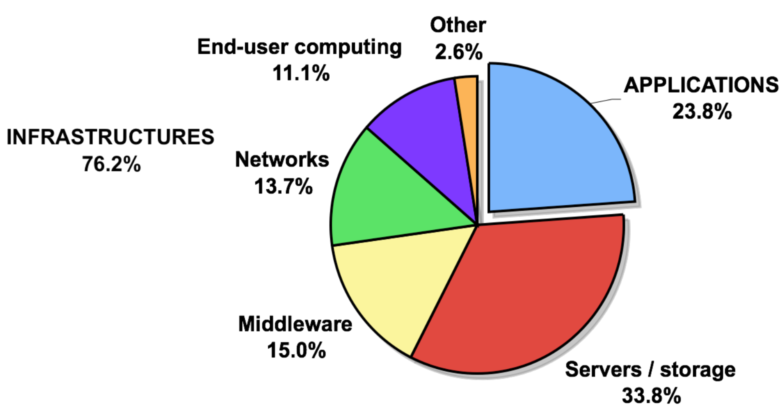


TOTAL: $428.73 BILLION

Source: International Technology Group

Alternatively, IT expenditure may be divided into applications and infrastructures. If projected Fortune 1000 IT expenditure in 2008 is broken down in this manner, results are as shown in figure 5.

Figure 5
IT Expenditure by Fortune 1000 Companies in 2008 (Projected): Alternative Breakdown



TOTAL: $428.73 BILLION

Source: International Technology Group

In this approach, "applications" costs include applications software license and maintenance fees, along with costs of in-house personnel and external services for application development, deployment, and ongoing support. All other costs are for infrastructures.

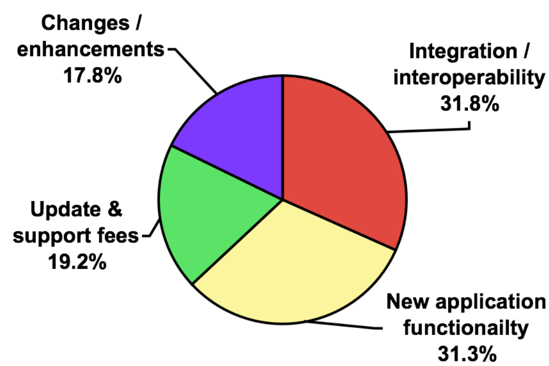
This means that, in 2008, more than three quarters of IT expenditure will be on infrastructures.

It gets worse. If applications expenditure is further broken down, it becomes apparent that less than a third of this goes into the delivery of new application functionality. The remainder is accounted for by costs for tools and programming for integration and interoperability, along with vendor update and support fees for installed applications, and incremental changes and enhancements to existing systems.

Figure 6 shows this distribution.

Figure 6

Applications-only Expenditure by Fortune 1000 Companies in 2008 (Projected)



TOTAL: $101.96 BILLION

Source: International Technology Group

The bottom line, then, is that only 31.3 percent of 23.8 percent – i.e. around 7.4 percent – of overall IT expenditure by Fortune 1000 corporations will go into the delivery of new application functionality.

Some qualifications are necessary here. As all too many organizations can testify, new applications do not necessarily deliver the business results expected from them. Equally, investments in application enhancements, in system integration and increased interoperability, or in the improvement of underlying infrastructures may deliver significant value to users.

Nevertheless, it is difficult to resist the conclusion that a fundamental misalignment has developed between business requirements and the manner in which overall IT resources are allocated. This has occurred because infrastructure efficiency, in most cases, has not been a central principle of IT strategy.

Fragmentation of infrastructures has diverted resources from direct to indirect value creation processes. The bottom-line effects of this would be difficult to quantify. But they are clearly substantial.

There may also be a larger implication. Inefficient infrastructures may reduce the flexibility with which IT resources can be exploited to respond to new business challenges. The ability of organizations to respond in a rapid, flexible, and effective manner to changing market and competitive conditions may be materially impaired. The impact will be magnified if this effect is neither recognized nor understood.

The real costs of infrastructure inefficiency may thus extend far beyond IT expenditures, and the proponents of "IT doesn't matter" who argue that IT has not delivered material competitive advantage to many businesses may thus have identified a legitimate problem. But they have misdiagnosed both the cause of and the solution to this problem.

Policies and Practices

There are a number of reasons why this imbalance has developed. The most significant is that organizations have allowed infrastructures to develop in a fragmented manner. This has not been an accident – many of the policies and practices of large IT organizations have encouraged this process.

This has particularly been the case in the following areas:

- ***Economic models***. Even where longer-term plans are in place, in practice most IT expenditure is driven by annual budgeting cycles. In infrastructure areas in particular, decision-making typically involves calculations based on last year's expenditure plus or minus X percent.

  This approach does not take account of embedded inefficiencies and, by discouraging large-scale, multi-year infrastructure investments to improve efficiency, tends to perpetuate the status quo.

  These effects are reinforced by capital accounting procedures that over-emphasize hardware, and by a tendency to focus on initial acquisition rather than multi-year lifecycle costs when planning investments. The result is that operating costs are progressively inflated over time.

  Vendor pricing also contributes. Price disparities between large and small servers, high-end and midrange storage systems, enterprise and departmental databases, and the like create incentives to purchase low-end offerings even when the long-term economic impact of these is negative.

  These dynamics recall the experiences of manufacturing sectors in a number of countries. Where investment strategies have been driven by short-term, internally focused criteria rather than external concerns such as competitiveness and response to market conditions, equipment bases and operating practices have tended to stagnate, and new technology adoption has slowed.

  Companies in which this has occurred have rarely prospered. Sooner or later, a disruptive force always enters the picture.

- ***Project methodologies***. Application deployment projects are typically structured on a case-by-case basis, with dedicated resources and cost justifications built around return on investment (ROI) calculations.

  ROI methodologies are designed to ensure that expenditure delivers quantified business returns in lower costs, reduced cycle times, increased market share, improved customer acquisition or retention, and other areas. While this approach is generally sound, it is often applied in a manner that increases overall infrastructure fragmentation.

  Applications are implemented on dedicated servers, and each project adds a new batch of application, database, Web, management, and other functionally specialized platforms. These are commonly replicated for production, development, test, quality assurance, training, and other functions.

  Over time, a succession of ROI-driven projects may thus result not only in a major expansion of server and database populations, but also in a plethora of new integration and interoperability requirements that drive up software and personnel costs long after projects have been completed.

  This does not mean that ROI-driven projects do not deliver business value. Clearly, many do. But ROI methodologies may embed structural inefficiencies that, in the future, will restrict the availability of resources for new initiatives.

- ***Resource sharing limitations***. Most IT organizations would operate in a more efficient manner if it was possible to share computing, storage, network, and other IT resources more effectively across different applications and workloads.

In most organizations, timesharing has been an established practice for mainframe systems for decades. Dozens to hundreds of applications are typically executed on the same physical platforms, and techniques for metering resource usage by individual applications are generally a more advanced than for other computing environments.

In many cases, resource usage metrics form the basis of chargebacks through which the business units that "own" applications are billed for their use of shared resources. While not universally accepted (some users prefer to avoid controversies that may arise about how costs are allocated), chargebacks have been generally successful in promoting data center efficiency.

Timesharing and chargebacks, however, have been less widely used for other platforms. To some extent, this has been due to technical factors – system architectures have been less well adapted to handle mixed workloads, and management tools have been comparatively weak. This has particularly been the case for Windows and Linux environments.

. Equally if not more important, however, has been that costs may be tracked more easily, and in a less controversial manner, if dedicated resources are employed to run applications for individual business units. As in other areas of IT infrastructure, responsiveness to users is not always conductive to efficiency.

- ***Skills and cultures***. The "commodity" model of the x86 server world has had major impacts on skill bases and organizational cultures. The ability to order low-cost hardware on an "as needed" basis has inevitably discouraged the adoption of more sophisticated, longer-term approaches to demand and capacity planning.

  The commodity model has also applied to skills. Training practices and certifications for Windows and Linux server administration tend to focus on basic skill sets. Organizations have implicitly assumed that more low-skill administrators are preferable to fewer administrators trained and equipped to manage more complex tools and technologies.

  (An example of both effects has been the comparatively limited demand for large n-way x86 servers. Despite evidence that these can realize economies of scale which more than justify their higher price tags, users have often been reluctant to employ them because procurement procedures are geared to lower-priced items, and because administrators find them unfamiliar.)

  This situation, which may also be found where large numbers of small UNIX servers and commodity storage systems are employed, tends to be self-perpetuating. Without investment in more advanced skills and practices, inefficiencies may become embedded in IT organizations as well as in the systems they support.

All of these factors have contributed to progressively higher levels of fragmentation. This in turn has meant that resources have been channeled into expansion, management, and operation of underlying infrastructures rather than into application-related investments.

Moreover, infrastructure fragmentation does not simply reduce the funds available for applications. It also contributes to comparatively high levels of investment in integration and interoperability, and change and enhancement tasks. More staff time and greater software outlays are typically required to integrate distributed than consolidated environments.

Development productivity also tends to be lower, and test and quality assurance overhead higher for complex software solutions implemented on multiple server platforms.

Conclusions

Two conclusions may be drawn. One is that, whether measured in terms of unproductive IT expenditure, lost opportunity, or reduced business agility, the costs of infrastructure inefficiency are potentially massive. In most large organizations, they will – by wide margins – exceed the costs of investing in effective enterprise management tools and practices.

The second conclusion is that creating infrastructure efficiency requires broad-based approaches that also address such issues as consolidation, application portfolio management, financial models, skill levels, procurement and operating practices and organizational cultures. It is not sufficient simply to deploy new tools. Larger processes of transformation are necessary.

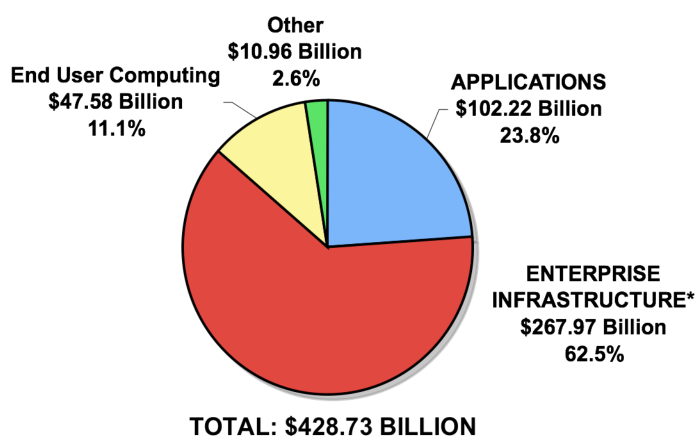
It is unrealistic to expect that such transformations can be initiated, funded, and managed within IT organizations. Corporate as well as business unit managements must be engaged in determination of objectives, allocation of resources, and measurements of success. Transformation must be a business-driven process whose goals are closely and explicitly linked to those of the enterprise as a whole.

If such transformations occur, however, the results in terms of cost savings, quality of service, and business contribution may more than justify the effort. The cost savings potential alone is substantial.

During 2008, as figure 7 illustrates, the infrastructure resources that are the focus of this report – servers, storage, middleware, and networks – represented approximately 62.5 percent of overall IT expenditure by Fortune 1000 corporations.

Figure 7

Enterprise Infrastructure Expenditure by Fortune 1000 Companies in 2008 (Projected)



***Includes servers, storage, middleware, & networks**
Source: International Technology Group

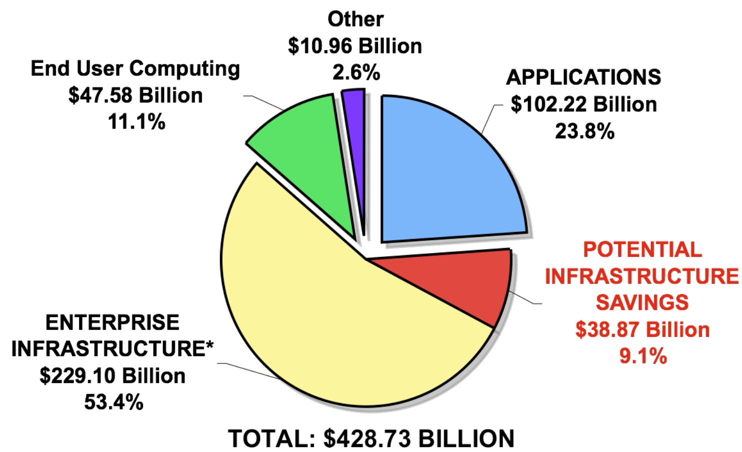
(The definition of infrastructure, in this context, does not include end user computing, which consists of hardware, software and services costs for PCs, local networks and peripherals, along with help desk and other personnel-related costs to service and support users of these. Savings in this area may also be substantial if existing practices allow for significant efficiency improvements.)

If actions such as consolidation of servers, storage, and networks, along with aggressive use of virtualization and "best practices" initiatives are coupled with organization-wide deployment of state-of-the-art integrated enterprise management solutions, the potential exists to realize at least a 14.5 percent reduction in overall enterprise infrastructure costs.

This would, as figure 7 illustrates, translate into a 9.1 percent reduction in overall IT expenditure – sufficient to more than double investments in the delivery of new application functionality.

Figure 8

Potential Savings in Enterprise Infrastructure Expenditure in Fortune 1000 Companies (Based on Projected 2008 IT Expenditure)



***Includes servers, storage, middleware, & networks**
Source: International Technology Group

IBM strategy is designed to help organizations addresses these challenges. Tivoli solutions address not only conventional data center management disciplines, but also management of applications and networks, as well as financial management, human resources management, and the processes through which IT service goals are defined, implemented, and monitored.

The unifying goal is to achieve gains in IT service delivery that map directly to and materially facilitate the realization of business objectives.

There are a number of other IT vendors that can address some of these issues. However, no competitor can match the breadth of IBM product and service capabilities, the depth of IBM experience in dealing with the challenges of IT transformation in large organizations, or the degree of strategic focus the company has brought to bear on meeting these challenges.

Server Challenges

Physical Server Proliferation

Despite replacements of older machines, periodic server consolidation initiatives, and – more recently – growing use of virtualization, physical server bases in most organizations have expanded steadily for more than a decade. Although the rate of growth shows signs of slowing, most industry observers project that expansion will continue.

This is due to a number of factors. These include continued preferences by many users for comparatively inexpensive small machines, complexity and skill issues that are retarding the rate at which organizations can assimilate virtualization technologies, and limitations in the ability of virtualized server environments to handle heterogeneous mixed workloads.

Organizations continue, moreover, to implement complex software architectures that require high levels of functional specialization among the servers that support them. IT departments are generally reluctant to virtualize production environments of this type, because use of dedicated servers is seen (often accurately) as reducing risks of performance bottlenecks and outages.

Replacement cycles further slow the rate at which consolidation occurs. Even in best practice installations, cycles are typically three to five years and, in most cases, replacement rates are slower. Organizations are often reluctant to incur the extra expense of accelerated replacement.

Experience has shown that users tend to cut back on new equipment purchases during recessions. Older, less efficient machines are retained longer than might otherwise be the case. There are signs that this is occurring because of the latest economic downturn.

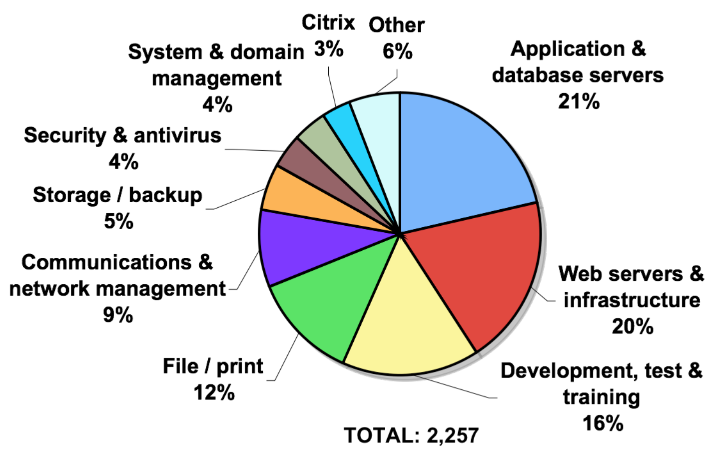
It can be expected that, because of the factors described above, most organizations will continue to face the challenges created by physical server proliferation far into the future. These challenges may be illustrated by the experiences of two companies that were consulted in preparing this report.

User Example: x86 Server Base

In this company, an in-depth audit of data centers found that 2,345 x86 servers were installed. The functions of 2,257 could be identified. The distribution of these was as shown in figure 9.

Figure 9

Distribution of Data Center x86 Servers by Function: User Example



The remainder served no apparent purpose, although they continued to occupy space and consume energy in idle mode. It was believed that they had supported applications that were later discontinued. (In this case, the number of unused servers appears to have been low. Most industry estimates are that between 5 percent and 10 percent of x86 servers in large organization data centers are unused.)

Around 20 percent of servers were less than two years old, 48 percent were two to five years old, and the remainder more than five years old. Servers ran at least 26 versions of seven different operating systems.

Budgetary pressures mean that older equipment and software versions are often retained unless there are pressing reasons to replace them. Even when servers are replaced on a regular basis, in many cases older machines were retained for comparatively light-duty applications.

Software update cycles often lagged and were poorly coordinated across servers supporting different applications and user groups.

It was estimated that there were between 90 and 100 full time equivalent (FTE) personnel within the company's IT department engaged in managing, maintaining, and updating software for this server base. Because administration procedures were poorly documented and job functions often overlapped, exact quantification was not possible. Individuals involved in server administration tasks held a variety of titles.

Overall, the IT department employed at least 24 different server management applications, ranging from basic bundled toolsets to sophisticated high-end systems. However, use of these varied widely across different groups of servers, and many of the functions of high-end systems were employed rarely or not at all. Old versions of all types of management application were common.

The situation in this company is representative of that of many large organizations. Two important conclusions may be drawn.

First, in the vast majority of organizations, large-scale replacement of old hardware and software versions is not a realistic option. An effective x86 server management strategy thus requires integration of multiple generations of hardware and software. The ability of Systems Director 6.1 to do this is central to its value.

Second, there are clear benefits to standardizing server management tools. Apart from the functional benefits of employing latest-generation tools, deployment provides an opportunity for organizations to improve and standardize management practices, and to ensure that IT staff are consistently and effectively trained in these. For IBM users, Systems Director 6.1 is the obvious candidate for standardization.

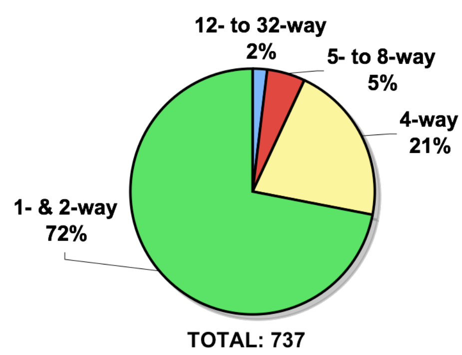
User Example: UNIX Servers

The challenges created by physical server proliferation are not restricted to Windows and Linux server installations. Many organizations that have deployed large numbers of small UNIX servers experience similar effects.

This company, for example, counted 737 Solaris servers. These were, as figure 10 shows, predominantly one and two-way machines.

Figure 10

Distribution of UNIX Servers by Size: User Example



Larger servers supported enterprise resource planning (ERP), customer relationship management (CRM), billing, and other major business systems, along with high-end analytical applications. These were typically managed by skilled staff, and operated to meet service-level targets that included high levels of availability and rapid response time. Business-critical systems were equipped for clustered failover.

The remaining servers, including most one- to four-way models, were employed for a variety of infrastructure, network, and departmental applications, as well as for mail, file and print serving, and development, test, and other non-production applications.

This part of the company's base was closer in profile to the x86 server installation described above. Servers were up to 10 years old, ran at least 21 releases of the SPARC and x86 variants of the Solaris operating system, and were supported by approximately 50 FTE IT personnel.

The exact number of personnel could not be determined. Job descriptions within the IT organization were often imprecise and, except for staff supporting business-critical systems, it was often unclear as to which functions were performed by whom for which platforms. Procedures were in many cases not documented, and such documentation as existed was often out of date.

Following a change in IT management, the company began to evaluate consolidation opportunities. To prepare for this, a review of capacity utilization was conducted. It was found that, over a 24-hour period, utilization typically ranged from less than 1 percent to around 30 percent. Peak utilization rates were, however, significantly higher – in some cases, 50 to 70 percent. Peak times varied between applications.

A key conclusion was that, if overall capacity utilization were to be significantly improved, it would be necessary to put in place tools that monitored utilization closely and distributed workloads to ensure that available server capacity was not overloaded during peak times.

In this case, it was decided to consolidate to IBM Power servers. To deal with utilization issues, the company planned to employ Power logical partitions (LPAR) and AIX workload management and Tivoli load balancing tools. Systems Director 6.1 would be deployed as the standard platform monitoring tool.

Blades and Virtualization

The two case studies presented above deal primarily with the effects of conventional server proliferation. Most organizations, however, will also face challenges caused by two other technology shifts: adoption of blade servers for Windows and Linux, as well as for UNIX applications; and virtualization, which is longer-established in the UNIX server world, but a comparatively new phenomenon in x86 server installations.

These challenges involve the following:

- ***Blade servers***. I/O and interconnect management tasks for blade configurations tend to be more complex than for conventional servers, and require the use of specialized fabric management tools. Integration of these into broader server management systems and processes may pose significant technical challenges.

  In addition, while blade servers may require less rack capacity and lower overall energy consumption, they concentrate heat generation within smaller physical spaces. Organizations have often found that they cannot fully populate blade enclosures without risking heat-related problems, or have been obliged to install specialized cooling devices, or both.

  These will be increasingly important issues for most organizations. There is general agreement among industry observers that sales of blade servers are growing more rapidly than for other server types. It is expected that blades will increase from less than 5 percent of overall server populations currently to between 20 percent and 30 percent within the next five years.

  The obvious implication is that blade server deployments need to be coupled with installation and effective use of tools for fabric integration and energy management.

  Systems Director 6.1 is designed to deal with these challenges. It allows for full integration of BladeCenter Open Fabric Manager (BOFM), the strategic IBM fabric management offering for the company's BladeCenter chassis and x86 and Power-based blade servers. BladeCenter complexes may be managed transparently through the Systems Director 6.1 console.

IBM Active Energy Manager, which forms part of the Systems Director product family, also fully supports BladeCenter systems. Benefits that may be realized by employing this product are discussed in the following section.

- ***x86 server virtualization***. Although VMware has been available for almost a decade, it has come into widespread use only recently. Apart from a small group of early adopters, organizations have only begun to develop experience with VMware and competitive tools such as Microsoft Virtual Server and Xen during the last few years.

  Users have been able to achieve high levels of physical server consolidation – VMware users, for example, routinely achieve ratios of 10:1 to 20:1 – and virtual server provisioning has proved to be a great deal faster and easier than acquiring, installing, and starting up new physical servers.

  As organizations have moved beyond small-scale projects toward larger-scale, production-oriented deployments, however, they have discovered that new challenges emerge. While potential benefits may be substantial, so are potential offsets. Figure 11 shows examples of both.

Figure 11
x86 Server Virtualization Benefits and Offsets: Examples

CONSOLIDATION	
Benefits	Numbers of physical servers may be reduced & capacity utilization improved, resulting in lower server hardware, software, maintenance, facilities, & physical resource management costs.
Offsets	Management complexities may increase significantly; additional administration tools & skills may be required; effective usage monitoring & capacity management may be required if virtual server workloads are not stable & predictable.
PROVISIONING	
Benefits	New virtual servers may be created in a fraction of the time, with significantly lower costs than setting up new physical servers.
Offsets	Effective capacity planning &/or spare physical server capacity may be required to ensure that workloads do not overload available capacity.
AVAILABILITY	
Benefits	Planned downtime may be reduced or eliminated for such tasks as hardware maintenance, operating system updates, & patching.
Offsets	Vulnerability to hardware failures may increase (multiple virtual servers may be disabled by failure of a single physical server); failover & recovery processes may become more problematic.
BACKUP & RECOVERY	
Benefits	Costs & time required for backup processes may be reduced (multiple virtual servers may be backed up simultaneously); recovery may be coordinated for multiple system instances.
Offsets	Administration complexity may be increased; greater network capacity; more expensive backup systems may be required.
SECURITY	
Benefits	Virtual servers concentrated on a single physical server represent a smaller attack profile.
Offsets	Single exploits may affect multiple virtual servers; patches may be required for virtualization software as well as operating systems; security administration complexity may be increased.
STORAGE	
Benefits	Virtual servers may be migrated between disk arrays without configuration changes.
Offsets	Storage capacity planning & management become less predictable; additional tools, processes, & skills may be required.

Although VMware (the company) offers a number of management tools, in practice, users have found that additional capabilities are required. This is also the case for Xen-based solutions.

Significant investments are also typically required in new management skills and practices. The current norm is, for example, that VMware skills command at least a 15 percent premium compared to conventional Windows and Linux server administrator salaries. This is expected to increase as VMware usage expands.

The management challenges posed by growth in blade server and VMware usage tend, moreover, to overlap. Many organizations choose to employ VMware on blades for server consolidation initiatives.

There is thus a strong business case for ensuring that an effective server management infrastructure is put in place at an early stage, before deployment of both technologies becomes pervasive.

Systems Director 6.1 can play a major role in achieving this goal. It allows for integrated management of virtual and physical server resources, including inventory, monitoring, alerting, and problem management capabilities for VMware, Xen, and Microsoft virtual servers.

For IBM users, there is the further benefit that Systems Director 6.1 allows for standardization of these processes across all of the company's major server platforms. BOFM, for example, supports Power- as well as x86-based BladeCenter servers, enabling integration of both into Systems Director 6.1 environments. Management capabilities also extend to PowerVM and z/VM virtualized resources.

The opportunity thus exists to preempt the new management challenges that will be posed to growing use of blades and x86 server virtualization. If this is done, the costs and difficulties of meeting these challenges will be a great deal less than if they are dealt with later, in a reactive and piecemeal manner.

Energy Management

Energy Pressures

Rising energy prices, corporate commitments to environmentally friendly "green" strategies and – in a growing number of data centers – constraints in physical capacity as well as in energy and cooling infrastructure have made energy efficiency an increasingly significant issue for many organizations.

According to a recent IBM estimate, for example, the cost of data center electricity supply has increased 30 percent over the last five years, and is expected to grow by at least the same percentage over the next three. Although there are some variations between individual estimates, numerous other sources confirm steep rises in data center energy costs.

For companies and government agencies that have adopted organizational "green strategies," data center energy consumption has also emerged as a priority focus.

In 2006, a report by the U.S. Environmental Protection Agency (EPA) estimated that servers and data centers accounted for 1.5 percent of total U.S. electricity consumption. This was more than twice the amount used in 2000. According to the report, if current trends continued, server and data center consumption would nearly double again by 2011.

This and other studies dealing with data center energy consumption, carbon emissions, and related subjects have been widely publicized. They have drawn corporate management attention to what, in the past, has been seen as an issue that concerned only IT departments.

Growth in numbers of servers and increasing server densities also pose serious challenges for many data center facilities. According to most industry estimates, the average age of U.S. data centers is in the range of 15 to 20 years, and some are more than 30 years old. Most were designed to handle energy consumption of no more than two to three kilowatts (kW) per rack, with corresponding thermal loading.

The current industry norm, however, is in the range of 5 kW to 10 kW per rack, and the trend is toward a doubling or tripling of this level within the next five years. High-density blade server installations have already reached 20 kW to 30 kW per rack.

A key implication is that organizations must deal with rising energy costs and thermal loading not only for the data center as a whole, but also at the rack and enclosure level. Data center energy efficiency strategies must be designed and managed with a significantly higher level of granularity than in the past.

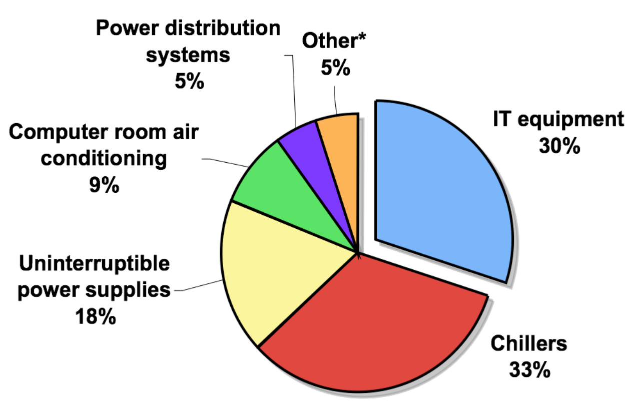
Server Energy Consumption

In most data centers, servers are the principal driver of energy consumption. Servers typically account for 70 percent to 85 percent of energy usage by IT equipment – significantly more than storage systems, networking equipment, and other devices.

Moreover, energy consumption is magnified by the amount of energy required for data center infrastructure equipment such as cooling units, uninterruptible power supplies (UPS), and power distribution and computer room air conditioning (CRAC) systems.

One industry estimate, illustrated in figure 12, is that approximately 70 percent of typical data center energy consumption is accounted for by such equipment.

Figure 12
Typical Data Center Energy Consumption by Type of Equipment



***Includes humidifiers (3%), lighting (1%), & switchgear & generating equipment (1%)**

Source: American Power Conversion

Most industry estimates are that between 60 percent and 80 percent of overall data center energy consumption is accounted for by infrastructure equipment. The actual energy impact of a server may thus be three to five times greater than appears to be the case.

Reducing Consumption

A variety of techniques may be employed to reduce data center energy usage. Consolidation and virtualization of servers and storage, along with use of blades –which typically consume 25 percent to 50 percent less energy than equivalent rack-mounted units – may have important effects.

Replacement of older servers has a broader impact. New technology models typically become more energy-efficient each year. Quad- or six-core processors, for example, consume only a fraction more energy than single- or dual-core equivalents. Higher density memory chips and improved system packaging have further contributed to lower energy consumption.

Organizations may also choose options such as high-efficiency power supplies – the industry norm for x86 server power supplies is in the range of 65 percent to 75 percent efficiency, compared to more than 85 percent for efficient devices. Use of 2.5-inch disk drives, which require less power to spin than 3.5-inch equivalents, may play a major role in lowering energy consumption for servers and storage systems.

At the data center level, energy consumption may be reduced through use of more energy-efficient infrastructure equipment, particularly UPS and PDS, as well as through improvements in computer room layout (e.g., "hot" and "cold" aisles, supplementary cooling units, improved underfloor airflow). A variety of other techniques, including emerging direct current (DC) power approaches, may be employed.

Effective use of energy monitoring, management, and load balancing tools may yield major gains. General industry experience has been that use of such tools alone results in a 10 percent to 20 percent reduction in data center energy consumption. Significantly larger reductions may be achieved if they are combined with other techniques.

IBM offerings enable use of all of these. Two levels of capability are provided. Active Energy Manager provides a standardized solution for server energy management, and a broader portfolio of Tivoli software and IBM services offerings address challenges at the data center level.

Active Energy Manager

Active Energy Manager provides a variety of functions that may be implemented at server, rack, and (for BladeCenter systems) chassis levels. These are summarized in figure 13.

Figure 13
Active Energy Manager Functions

FUNCTION	DESCRIPTION
Thermal trending	Monitor & display ambient temperatures, including inlet & exhaust temperatures; display & analyze trends.
Power trending	Track & display power usage data; display & analyze trends.
Power saver	Set/schedule reduction of voltage & frequency by fixed percentage within pre-determined to be safe operating limit.
Power capping	Set/schedule "hard" & "soft" (flexible) energy usage caps; AEM will throttle back voltage & frequency if system approaches cap.
CPU trending	Determine actual CPU speed of processors for which power saver or power capping is active; display & analyze trends.

The full set of Active Energy Manager functions are supported on IBM System x and BladeCenter as well as POWER6-based Power servers. For Power servers, power saver mode is supported only for 4.0 GHz and faster processors.

Active Energy Manager also manages IBM EnergyScale capabilities in latest-generation POWER6-based Power servers. EnergyScale technology employs embedded control functions and sensors located at key points within the system unit to provide additional functions that are summarized in figure 14.

Figure 14

Additional EnergyScale Energy Management Functions

FUNCTION	DESCRIPTION
Dynamic power savings	Automatically adjust voltage & frequency settings based on workload; select whether server operations should be optimized for energy efficiency or performance.
Power efficient fan control	Fan speed setting based on server usage & ambient temperatures; altitude input.
Processor core nap mode	Automatic processor stop when idle.
EnergyScale for I/O	Automatic power-off of pluggable PCI adapters when idle.
Guaranteed safety	Features designed to ensure continued operation of the system during adverse power or thermal conditions.

Thermal trending and power trending functions are supported for System z10 models, and for older System p servers, IBM storage systems, and other IBM and non-IBM platforms using intelligent power distribution units (iPDUs), including IBM PDU+ offerings and third-party equivalents.

Active Energy Manager provides the ability to monitor in real time, as well as to record and analyze actual energy usage and thermal loading.

This data may be used to allocate energy on a server-by-server basis and to set thresholds for individual server energy usage based on application priorities, time of day, and other factors. It can also play a major role in enabling organizations to develop more effective data center energy conservation strategies.

Control functions such as power capping require knowledge of actual energy consumption to be effective. Capping enables administrators to reduce the margin of power available to a server or group of servers. This approach is particularly valuable to organizations whose utility contracts penalize them if consumption crosses a particular threshold.

One of the key benefits of measuring actual energy consumption is that organizations can avoid working with “nameplate” values.

Nameplate ratings are required measurements of power consumption by Underwriters Laboratories in the United States and equivalent bodies in other countries. They assume maximum workloads and “worst case” environmental conditions.

Many data centers continue to plan and operate using these values, with the result that facilities’ infrastructures are often overconfigured, and server bases are overpowered. Industry tests have shown that nameplate ratings for IT equipment are typically at least 33 percent higher than actual consumption.

Distortions are magnified if data center managers add safety margins to projected “normal” consumption when planning facilities infrastructures and placing utility contracts. If normal consumption is based on nameplate values that are, say, 35 percent too high, and a further 20 percent is added as a safety margin, the organization will be working with seriously erroneous assumptions about its energy requirements.

Active Energy Manager can also monitor power distribution, UPS, CRAC, and other data center infrastructure components. Interfaces are also supported to SynapSense wireless sensor nodes and to the Liebert SiteScan system, which monitors and controls Liebert cooling and power equipment supplied by Emerson Network Power.

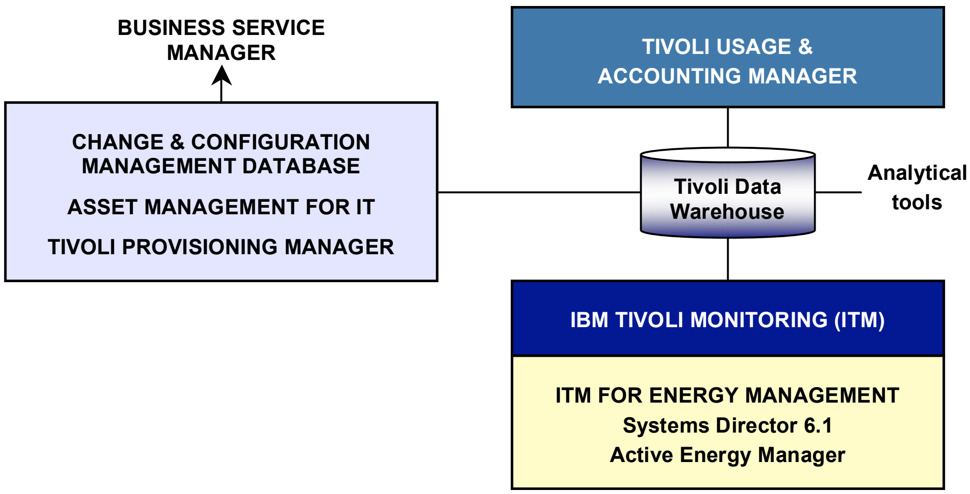
Data Center Level

At the data center level, the key IBM solution is IBM Tivoli Monitoring (ITM) for Energy Management. This extends the core ITM application to cover thermal and energy usage data. It incorporates Systems Director 6.1 as well as Active Energy Manager.

Energy-related data collected through ITM for Energy Management may be aggregated in the Tivoli Data Warehouse for analytical purposes, and shared with other Tivoli solutions. This scenario, which is illustrated in figure 15, enables a number of new applications.

Figure 15

IBM Tivoli Energy Management Scenario



Energy usage data, for example, may be maintained in the Tivoli Change and Configuration Management Database, and used to develop energy-aware inventories through Asset Management for IT, and server provisioning policies through Tivoli Provisioning Manager.

Tivoli Usage and Accounting Manager may be employed to implement energy chargebacks, or to incorporate energy consumption into existing chargeback arrangements. This has often proved to be a critical success factor in reducing usage. Chargebacks may provide a level of motivation for users that is both greater and longer lasting than is the case for less bottom line-oriented green initiatives.

Energy management policies may also be related to SLAs through Business Service Manager to ensure that power capping does not affect response time commitments.

Information on data center equipment and building automation systems may be maintained in Asset Management for IT or Maximo databases for valuation, maintenance scheduling, and planning purposes.

IBM has also taken an industry lead in integrating power, cooling, and building automation systems into its data center energy management solutions. A series of agreements with leading suppliers of these, summarized in figure 16, has enabled ITM for Energy Management to monitor and collect data from all major components of facilities infrastructures.

Tivoli solutions, along with IBM best practice models and services capabilities, encompass all of the major tools, technologies, and practices that may be employed to reduce data center energy consumption.

Figure 16

ITM for Energy Management Support by Facilities Automation System Suppliers

VENDOR	ITM INTERFACES TO:
American Power Conversion (APC) & TAC (subsidiaries of Schneider Electric)	**APC InfraStruXure Central & TAC building management systems** – provide monitoring, fault management & reporting for power, cooling, security, & environmental systems.
Eaton Corporation	**Power Xpert application** – collects & analyzes power usage data for data center infrastructure equipment.
Emerson Network Power	**Liebert SiteScan** – monitors & controls Liebert cooling & power equipment.
Johnson Controls	**Metasys building management system** – controls air handling, lighting, security, utility monitoring, & other building functions.
Matrikon	**MatrikonOPC integration software** – enables data flows from third party building management systems & automation devices using OLE for Process Control (OPC) standards.
OSIsoft	**PI System** – consolidates data from third-party infrastructure & building automation systems through 480+ interfaces.
Siemens Building Technologies	**Siemens building automation systems**
SynapSense Corporation	**SynapSense wireless sensor network solutions**

Industry experience has shown that the most effective approaches to reducing data center energy consumption employ a variety of tools and techniques, and combine them with broader programs that also address management goal-setting and operational processes. IBM is one of the few industry players that can address all of these requirements.

Management Solutions

Systems Director 6.1

Overview

Systems Director 6.1, which replaces the earlier IBM Director 5.20 product, is designed to provide a unified management solution for IBM System x and BladeCenter, Power and (for Linux guests) System z platforms, as well as for distributed disk systems and SAN resources.

Recent versions of Windows Server 2003, Red Hat Enterprise Linux (RHEL), SUSE Linux Enterprise Server (SLES), and the IBM AIX and i operating systems are supported, along with Windows Server 2008 and VMware ESX, Microsoft Virtual Server, PowerVM (for Power servers) and z/VM (for System z servers) hypervisors, and the Xen components of RHEL and SLES.

Systems Director 6.1 forms the core of a product family that consists of a set of base plug-in modules, along with a number of advanced function products. These are summarized in figure 17.

Figure 17
Systems Director Product Family

SYSTEMS DIRECTOR 6.1 BASE PLUG-INS	
Discovery Manager	Discovers physical & virtual resources; maintains hardware & software inventory; visualizes network relationships.
Status Manager	Monitors hardware, power & update status, & provides event notifications; summary, dashboard & scorecard functions display & analyze status of managed resources.
Configuration Manager	Provides central point & single framework for configuring physical & virtual resources & performing OS or device-specific configuration functions; manages configuration settings, templates, & plans; automatically configures newly discovered systems.
Update Manager	Manages download & installation of software updates; tracks update status & alerts system administrators of out-of-compliance resources.
Automation Manager	Automates customized response to events; manages task activations.
Remote Access Manager	Provides integrated toolset for remote access & control.
Virtualization Manager	Provides lifecycle management, including creation, editing, relocation & deletion of virtual resources including virtual servers & farms; tracks system status & alerts, & creates automated event response plans.
Security features	User authentication & role-based access control.
ADVANCED FUNCTION PRODUCTS	
Active Energy Manager	Provides multiple functions that may be implemented at the rack or server level. These include monitoring, recording, & analysis of energy usage & thermal loading; capping; & setting of energy & temperature thresholds. Also monitors data center support devices including PDS, UPS, CRAC equipment, & SynapSense nodes; receives alerts from third-party facilities management applications.
BladeCenter Open Fabric Manager (BOFM)	Manages I/O & network interconnects for up to 100 BladeCenter chassis with up to 1,400 servers. Provides a single administrator login to these. Also detects failures, automates failover to & restart of alternate blade servers, & transfers MAC & WWN network addresses to alternate I/O ports.
Tivoli Provisioning Manager for OS Deployment (TPMfOSD)	Enables automated network deployment of server firmware & software, including BIOS & driver updates, & IBM AIX, Windows Server & Vista, Linux, Solaris, & MacOS operating system images.
Service & Support Manager	Identifies & reports hardware-related problems. Interfaces to Status Manager & uses Electronic Service Agent to gather service information & report problems to IBM.

Systems Director 6.1 allows for the use of standardized set of management tools and processes for all physical and virtual resources for all supported server platforms, operating systems, and hypervisors. Access is through a common management console, using a single Web-based administrator interface.

All modules and related products may run on IBM System x, BladeCenter and Power servers with all supported operating systems and hypervisors.

All base plug-ins except the Virtualization Manager may be employed for System z Linux guests. IBM has announced plans to support the latter during 2009. Active Energy Manager may also used to monitor System z energy usage and thermal loading, although functions such as energy thresholding and capping are not enabled for this platform. No other related products are currently supported for System z Linux.

IBM has announced plans to deliver, starting in the first quarter of 2009, new versions of Active Energy Manager, BladeCenter Open Fabric Manager, and a new Virtual Server Image Manager product as plug-ins to Systems Director 6.1.

The Virtual Server Image Manager, according to IBM, will enable customization and automated distribution of virtual system images for supported x86 virtualization enablers and for IBM Power, System z, and disk system platforms.

Main Components

There are four main components of a Systems Director 6.1 deployment:

1. ***Systems Director Server*** acts as the central management server. It may be deployed on AIX, Windows Server, or Red Hat or SUSE Linux and may be configured for high availability (HA) operations. Apache Derby (for small environments) or IBM DB2, Oracle, or SQL Server may be employed for management databases.
2. ***Management Console*** provides a common browser-based interface for administrators to the full set of Systems Director tools and functions for all supported platforms.
3. ***Common and Platform Agents*** reside on managed servers running supported operating systems and hypervisors. Common Agent enables use of the full suite of Systems Director 6.1 services. Platform Agent implements a subset of these. It provides a small footprint option for servers that perform limited functions or are equipped with less powerful processors.
4. ***Agentless support*** is provided for x86 servers that run older versions of Windows or Linux operating systems, along with other devices that conform to Distributed Component Object Model (DCOM), Secure Shell (SSH), or Simple Network Management Protocol (SNMP) specifications.

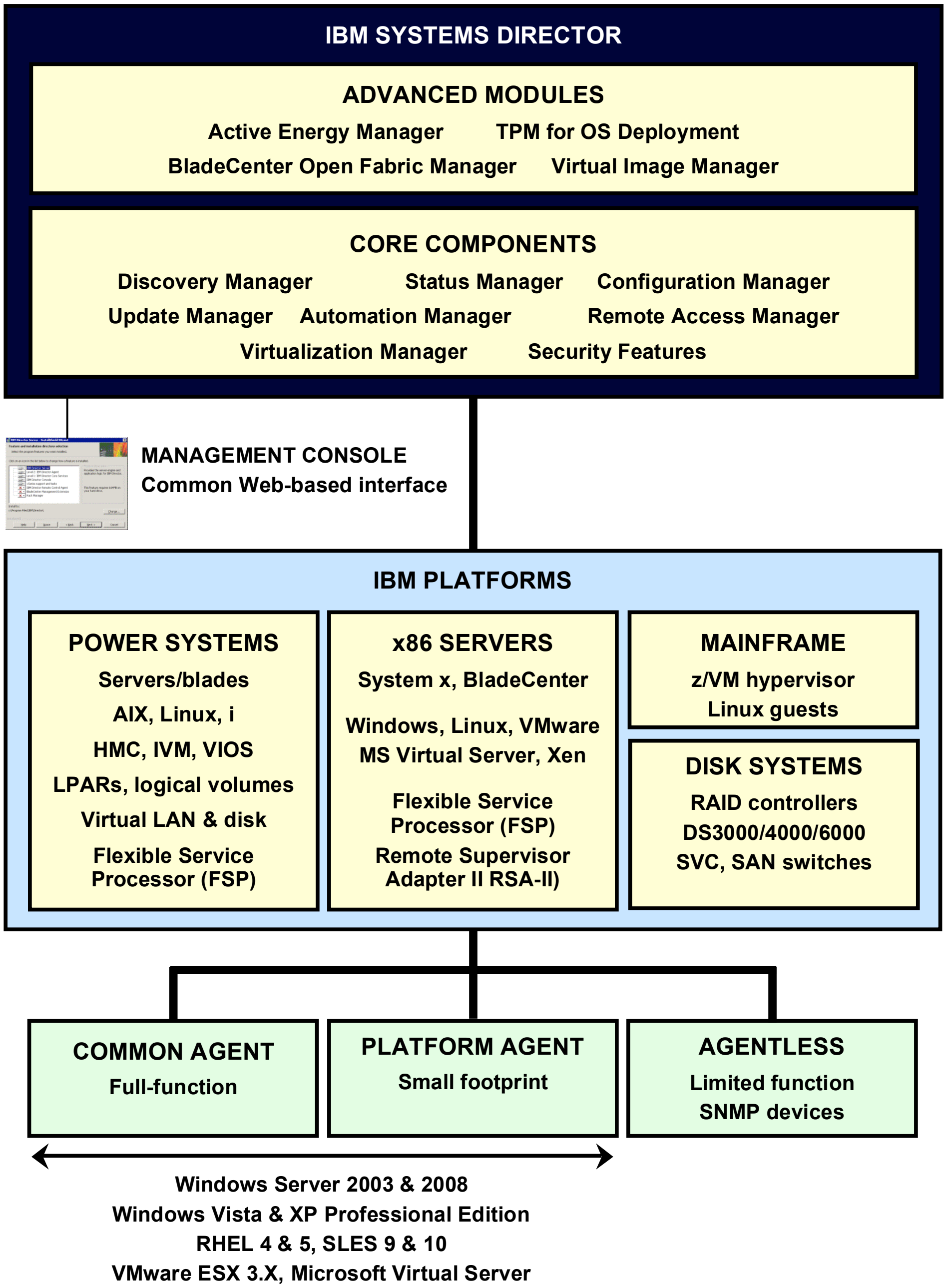
For Power servers, Systems Director 6.1 support extends to logical partitions (LPARs), Virtual I/O Servers (VIOS), and other virtual resources enabled by PowerVM technology. The principal PowerVM tools for management of these – the Hardware Management Console (HMC) and Integrated Virtualization Manager (IVM) – may be accessed through the Systems Director 6.1 administrator interface.

Systems Director 6.1 interfaces directly with embedded Flexible Service Processors (FSPs), which provide local resource monitoring, data collection, and alerts for Power as well as System x servers; and with the System x Remote Supervisor Adapter II (RSA II), which provides remote management functions for System x servers.

Systems Director 6.1 servers may also be employed to manage IBM server RAID controllers; DS3000, DS4000, and DS6000 disk systems; SAN Volume Controller software, and IBM-supported SAN switches from such vendors as Brocade, Cisco Systems, Nortel Networks, and Qlogic.

The overall Systems Director 6.1 environment is summarized in figure 18.

Figure 18
Systems Director 6.1 Environment



Older IBM platforms, including System p and pSeries, System i and iSeries, and xSeries servers, may also be managed if they run operating system versions supported by Systems Director 6.1.

A single Systems Director 6.1 server can manage thousands of physical and/or logical servers equipped as Common or Platform Agents. There is no limit to the number of SNMP devices that may be managed.

Tivoli Solutions

Solution Portfolio

The Tivoli product line is the broadest offered by any enterprise management vendor, consisting of more 450 major and 500 niche and legacy products.

The principal Tivoli solution offerings may be grouped into 13 main categories, which may be summarized as follows:

1. ***Business Service Management*** consists of tools and processes for service-level management, which in the IBM definition includes definition and monitoring of service level agreements as well as goal-setting, performance measurement, and service strategy planning.

   The core component of this category is *Tivoli Business Service Manager*, which enables continuous measurement of service availability and performance against business goals. It incorporates analytical and visualization tools as well as scorecarding, key performance indicator (KPI) tracking, and other monitoring functions.

   Other key components include *Omnibus*, a former Micromuse offering for real-time data center and network operations monitoring; the *Tivoli Service Request Manager* service desk application; *Service Level Advisor* for designing and evaluating SLAs; and *data integration tools* which enable cross-organizational collection and aggregation of service-related data.

2. ***Change and Configuration Management*** consists of two main components. *Tivoli Application Dependency Discovery Manager (TADDM)* provides discovery of a wide range of IBM and non-IBM IT resources, including virtualized resources, establishes relationships between these, and maps both to business applications.

   Change and Configuration Management Database (CCMDB) acts as the central enterprise repository of resources and relationships discovered by TADDM. Combined with the latter, it provides the bridge between conventional IT asset and operations management functions and higher-level Business Service Management processes.

3. ***Process Management*** consists of a set of customizable workflow-based tools and best practice models that enable organizations to automate key operational processes using CCMB data.

   Key offerings include *Availability Process Manager* (event management), *Business Continuity Process Manager* (disaster recovery), *Capacity Process Manager* (capacity management) *Change Process Manager* (change management), *Configuration Process Manager* (configuration management), *Release Process Manager* (release management), *Storage Process Manager* (storage management), and *Unified Process Composer* (documentation of these and other operational processes).

4. ***Monitoring and Event Management*** includes *Tivoli Monitoring* and *Composite Application Manager*, which provides additional capabilities for complex multiplatform environments.

   Specialized Composite Application Manager modules are offered for management of service oriented architecture (SOA), IBM WebSphere, Java 2 Platform Enterprise Edition (J2EE), Web services and Microsoft applications; Internet service and transaction processing systems; and other software environments.

   An extension to Tivoli Monitoring, *Tivoli Performance Analyzer*, adds capacity utilization monitoring and predictive analysis functions allowing early detection of performance bottlenecks.

5. ***Provisioning*** includes *Tivoli Provisioning Manager***,** which provisions and configures a wide range of IBM and non-IBM servers, operating systems, middleware, applications software, and storage and network resources; and *Tivoli Intelligent Orchestrator*, which enables automation of provisioning-related processes based on organization-specific requirements.

6. ***Workload Automation*** includes the core *IBM Enterprise Workload Manager* solution for complex workload management, along with *Tivoli Workload Scheduler* for job scheduling and *Tivoli Dynamic Workload Broker* for automated workload routing.

   Tivoli Workload Scheduler includes specialized modules for management of ERP workloads (*Workload Scheduler for Applications*), grid environments (*Workload Scheduler for Virtualized Data Centers*), and parallel processing systems employed for high-performance computing applications (*LoadLeveler*).

7. ***High Availability*** includes *Tivoli System Automation for Multiplatforms*, which automates failover and recovery processes for Veritas Cluster Server and IBM High Availability Clustered Multiprocessing (HACMP) for AIX and Linux servers, and *Tivoli System Automation for z/OS*, which provides comparable services for Parallel Sysplex and Geographically Dispersed Parallel Sysplex (GDPS) clusters.

8. ***Storage Management*** includes *IBM TotalStorage Productivity Center*, the company's strategic storage resource management suite; *Tivoli Storage Manager* for data backup and recovery; *System Storage Archive Manager* for policy-based archiving; and *SAN Volume Controller*.

9. ***Network Management*** includes *Tivoli Network Manager*, formerly Netcool/Precision, which is the principal IBM solution for management of IP networks; and the *Tivoli NetView* suite for management of conventional mainframe-based networks. Tivoli Network Manager includes *IP Edition* and Transmission Edition layers 2 and 3 and layer 1 networks respectively.

10. ***Financial Management*** includes *Tivoli Usage and Accounting Manager (TUAM)* for resource usage metering, accounting, and billing. Originally developed by CIMS Lab, which was acquired by IBM in 2006, TUAM is commonly used to implement chargebacks.

    Other financial management applications include *Tivoli License Compliance Manager* tools which maintain inventories of and determine license costs and compliance requirements for IBM and third-party software; and *IBM License Metric Tool*, a no-charge tool that assists in calculating license costs for IBM software based on processor value unit (PVU) pricing.

11. ***Asset Management*** consists primarily of the Maximo-based *IBM Tivoli Asset Management for IT* and *Tivoli Integration Composer*, a data integration tool that enables collection and aggregation of IT asset-related data from diverse sources.

12. ***Security, Risk, and Compliance*** includes a broad portfolio of security-related solutions. These include the core *Tivoli Access Manager* and *Tivoli Identity Manager* solutions, along with *Tivoli Federated Identity Manager* for partner data sharing, *Tivoli Risk Manager* for security event management, and *Tivoli Directory Server*.

    Also forming part of this portfolio are *Tivoli Compliance Insight Manager* for security compliance monitoring, *Tivoli Key Lifecycle Manager* for enterprise-level management of encryption keys, and the *zSecure* mainframe audit management suite. The zSecure suite was developed by Consul Risk Management, which was acquired by IBM in 2006.

13. ***Data Center Transformation*** is a new category that will be the subject of future IBM initiatives. Currently the only solution in this category is *Tivoli Monitoring for Energy Management.*

These categories are summarized in figure 19.

Figure 19
IBM Tivoli Solution Categories

BUSINESS SERVICE MANAGEMENT		
Business Service Manager	Service Request Manager	Service Level Advisor
OMNIbus	Data Integration Tools	
CHANGE & CONFIGURATION MANAGEMENT		
Change & Configuration Management Database	Application Dependency Discovery Manager	
PROCESS AUTOMATION		
Availability Process Manager	Business Continuity Process Manager	Capacity Process Manager
Change Process Manager	Release Process Manager	Storage Process Manager
MONITORING & EVENT MANAGEMENT		
IBM Tivoli Monitoring (ITM)	Composite Application Manager	Performance Analyzer
WORKLOAD AUTOMATION	**PROVISIONING**	**HIGH AVAILABILITY**
Enterprise Workload Manager	Provisioning Manager	System Automation for Multiplatforms
Dynamic Workload Broker	Provisioning Manager for OS	System Automation for z/OS
Workload Scheduler	Provisioning Manager for Software	
	Intelligent Orchestrator	
STORAGE MANAGEMENT	**NETWORK MANAGEMENT**	
	IP Networks	**Mainframe Networks**
Archive Manager	Network Manager	NetView for z/OS
Storage Manager	• IP Edition	NetView Distribution Manager
TotalStorage Productivity Center	• Transmission Edition	NetView Performance Monitor
SAN Volume Controller		
ASSET & FINANCIAL MANAGEMENT		
Usage & Accounting Manager	License Compliance Manager	Asset Management for IT
License Metric Tool	License Compliance Manager for z/OS	Maximo Suite
SECURITY, RISK, & COMPLIANCE		
Access Manager	Federated Identity Manager	Key Lifecycle Manager
Identity Manager	Directory Server	Compliance Insight Manager
Identity Manager for z/OS	Directory Integrator	zSecure Suite
DATA CENTER TRANSFORMATION		
Energy Management		
ITM for Energy Management		

Also forming part of the Tivoli solution portfolio is Tivoli Data Warehouse, a DB2-based framework designed to interface to the principal Tivoli data collection solutions. Tivoli Data Warehouse is available for Tivoli-branded applications at no additional charge.

Although certain components have been incorporated into the mainstream Tivoli solution portfolio, IBM also continues to market a number of specialized suites separately.

These include ***Netcool*** solutions for communications and Internet service providers, originally developed by Micromuse; ***Maximo*** enterprise asset management solutions originally developed by MRO Software; and the ***Omegamon XE*** product family of tools designed to manage mainframe software platforms, storage, and networks. The Omegamon XE family was originally developed by Candle, which was acquired by IBM in 2004.

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