



MAN Nutzfahrzeuge AG: An Infrastructure Built on Linux and IBM Technology

An IDC e-business Case Study

THE SUBJECT

Based in Munich, Germany, MAN Nutzfahrzeuge AG is one of Europe's three largest commercial vehicle manufacturers, with principal products including trucks and buses. A unit of the MAN Group, MAN Nutzfahrzeuge AG employs approximately 35,000 and generated revenues of Euro 6.7 billion (\$6.3 billion) in 2001.

THE GOAL

As the number of users and the volume of e-business activity increased, MAN needed an infrastructure that could deliver performance, scalability and high availability. In addition to superior performance, MAN needed an infrastructure whose management was both efficient and economical.

THE SOLUTION

MAN's solution is an integrated, Java-based infrastructure powered by WebSphere Application Server running on Linux clusters. The intranet portion of the solution provides MAN employees with access to applications ranging from basic data searching to Knowledge Management, Data Warehousing and ERP. MAN's extranet provides customers, suppliers, distributors, dealers and other MAN business units with a range of data sharing, collaborative, and transactional applications.

WHY IBM

"With a cluster-based architecture, we naturally saw load balancing as critical to the performance, scalability, and availability of the solution. Working together, WebSphere Edge Server and Application Server allowed us to optimize the performance of the solution."



Table of Contents

Executive Summary	1
Situation Analysis	2
Background	2
The Need: A Secure, Industrial-Strength Infrastructure	2
Action Plan and Decision Process	3
First Steps	3
Challenges	4
Exhibit: Challenges Encountered in MAN's e-business Evolution	4
Solution Profile and Implementation Strategy	5
The Solution: Core Functionality and Architecture	5
Exhibit: Basic Architecture of MAN's Intranet/Extranet Solution	6
Security Profile	7
MAN's Solution in Action	7
The Project: Development Approach and Timetable	8
Exhibit: Development Timetable for MAN's e-business Solution	8
Business Results	9
Exhibit: Overview of MAN's Business Results Achieved	9
Case Epilogue	10

Executive Summary

MAN Nutzfahrzeuge AG, a leading manufacturer of commercial vehicles in Europe, recognized the need to upgrade its e-business infrastructure to accommodate steady increases in usage volume. MAN's previous solution was fragmented, decentralized and hard to manage—having grown up from individual initiatives across the company. The company decided to adopt an integrated, cluster-based architecture that would deliver higher performance, increased availability, and easier management.

Linux was selected as the Web and application server operating systems because it allowed MAN to expand its infrastructure at low incremental cost. For the core of the solution, MAN selected IBM's WebSphere family of products (WebSphere Application Server, Edge Server and MQ) on the strength of its load balancing capabilities, support for standards and ease of integration with backend applications. MAN continues to evolve its e-business infrastructure, evidenced by recent initiatives employing the Web Services model.

MAN's Solution at a Glance

e-business Stage	Integrating
Core Functionality	MAN's infrastructure solution is comprised of three key segments 1.) its intranet provides MAN employees with access to applications ranging from basic data searching to Knowledge Management, Data Warehousing and ERP. 2.) MAN's extranet provides customers, suppliers, distributors, dealers and other MAN business units with a range of data sharing, collaborative, and transactional applications. 3.) MAN's public Web site provides primarily company and product information.
Software	WebSphere Application Server (Advanced Edition, Version 3.5), WebSphere Edge Server, WebSphere Studio Application Developer (formerly VisualAge for Java), DB2 Universal Database, WebSphere Studio (Advanced Edition), WebSphere MQ, IBM HTTP Server
Servers	IBM eServer zSeries (formerly IBM S/390), IBM RS/6000
Key Benefits	<ul style="list-style-type: none">• Moving to a cluster-based architecture has given MAN the ability to service and upgrade its infrastructure while providing users with 24 by 7 availability.• MAN's cluster-based architecture allows the company to expand its capacity by adding low-cost servers on an as-needed basis.• WebSphere's load balancing features have provided MAN with a marked improvement in the solution's performance, stability and overall quality of service.• MAN's embrace of the WebSphere platform has allowed it to streamline and better define its software development process, putting the company in a stronger position to develop, deploy, integrate and manage dynamic e-business applications.

Background

Based in Munich, Germany, MAN Nutzfahrzeuge AG is one of Europe's largest commercial vehicle manufacturers; the company's principal products include trucks and buses. A unit of the MAN Group, MAN Nutzfahrzeuge AG (MAN) employs approximately 35,000 and generated revenues of Euro 6.7 billion (\$6.3 billion) in 2001. The company operates manufacturing facilities in five countries, including Germany (Munich, Salzgitter, Nuernberg, Gustavsburg and Penzberg), Austria (Vienna and Steyr), Poland (Posen and Starachovice), Turkey (Ankara) and South Africa (Johannesburg and Pinetown).

The Need: A Secure, Industrial-Strength Infrastructure

As a leading industrial manufacturer, MAN has forged a series of collaborative links with its many suppliers, channel partners, and customers. To keep up with the growing breadth, depth and sophistication of these external linkages, the company has invested heavily in its e-business infrastructure—ranging from extranets to integration with backend systems. The company has been equally aggressive in deploying intranet technology to support collaboration and communications among its employees. Like most companies, MAN had—by early 2001—presided over a fragmented, decentralized Web infrastructure that had grown up from individual initiatives across the company.

Like most companies, MAN had—by early 2001—presided over a fragmented, decentralized Web infrastructure that had grown up from individual initiatives across the company. With the company poised to expand its e-business activity, the need to have the appropriate infrastructure in place was recognized as crucial.

With the company poised to expand its e-business activity, the need to have the appropriate infrastructure in place was recognized as crucial. Thus, as the number of users and the volume of e-business activity increased, MAN needed an infrastructure that could deliver performance, scalability and high availability. On top of superior performance, MAN needed an infrastructure whose management was both efficient and economical to keep its burgeoning e-business volume from dragging up support costs.

MAN began a study designed to assess its requirements and capabilities in March 2001. At the conclusion of the month-long study, the company had earmarked a number of potential obstacles to its e-business ambitions. Internally, departmental intranet resources had sprouted throughout the company and grown unchecked, making management difficult and raising software costs. Support was also a point of vulnerability for MAN's core systems, which needed to be shut down on off hours to perform routine system maintenance. Given the geographic dispersion of MAN's operations and the increasing scope of usage among its e-business stakeholders, the need to provide 24 by 7 availability was seen as a must.

According to Dr. -Ing Johannes C. Lorenz, Manager of Software Production Environments, MAN's vision was to deploy an integrated Web infrastructure that would put the company on a firm footing for the future. "We saw shifting the applications to an n-tiered architecture as a cost effective way to achieve our performance, scalability, and support goals simultaneously," he says.

“This architecture was also seen as a way for us to integrate all of our Java and Web applications and deliver them in a consistent way across our intranet and extranet environments.”

Action Plan and Decision Process

First Steps

Having articulated its vision of an infrastructure for the future, MAN set out in April 2001 to select the strategy, architecture and technology components required to transform it into a working solution. On the hardware side, MAN needed to select a server architecture that met its performance requirements, provided an unlimited upgrade path, and was extremely cost-efficient. As Dr. -Ing Lorenz explains, this required MAN to make some very fundamental decisions. “We faced two basic choices—either buy now what we would need *two years* down the road or start small and grow as needed,” he says. “Ultimately, we saw a clustering approach—relying on high-end database servers for mission-critical data and lower-cost servers for RAM- and CPU-intensive Java-Applications—as the best way of achieving our goals.” One of the key drivers in this decision was the ability to grow the processing-intensive portion of the solution by adding low-cost servers that could be centrally managed.

“We have 20 years worth of mission-critical applications running on our backend systems, so the ability to adapt them—as opposed to replacing them—is an absolute requirement. WebSphere offered us various tools to make these adaptations.”

— Dr. -Ing Johannes C. Lorenz, Manager, Software Production Environments, MAN Nutzfahrzeuge AG

MAN’s software selection process focused on four key areas:

- *Operating System*—The platform on which MAN’s server clusters would run.
- *Web Application and Load Balancing Servers*—To run MAN’s Java applications and to control traffic flow to the server cluster.
- *Messaging Middleware*—To integrate MAN’s Java-based front end with backend applications residing on its existing mainframe.
- *Data Access Framework*—To access MAN’s databases residing on a variety of UNIX and MVS database servers.

While MAN gave some consideration to a variety of UNIX-based operating systems, Linux was the front runner from early on by virtue of its stability, uptime, maintainability and compatibility with MAN’s low-cost, cluster-based strategy (discussed in greater depth in the following section) and was ultimately selected.

For its Web Application Server, MAN evaluated several commercial and open-source products. As Dr. -Ing Lorenz points out, MAN selected WebSphere Application Server because it best enabled the company to integrate with its backend zSeries systems, many of which resided on IBM DB2 databases. “We have 20 years worth of mission-critical applications running on our backend systems, so the ability to adapt them—as opposed to replacing them—is an absolute requirement,” he says. “WebSphere offered us various tools to make these adaptations.” Another key factor cited by Dr. -Ing Lorenz was the “very tight integration” of load balancing features within WebSphere Application Server, embodied by WebSphere Edge Server. “With a cluster-based architec-

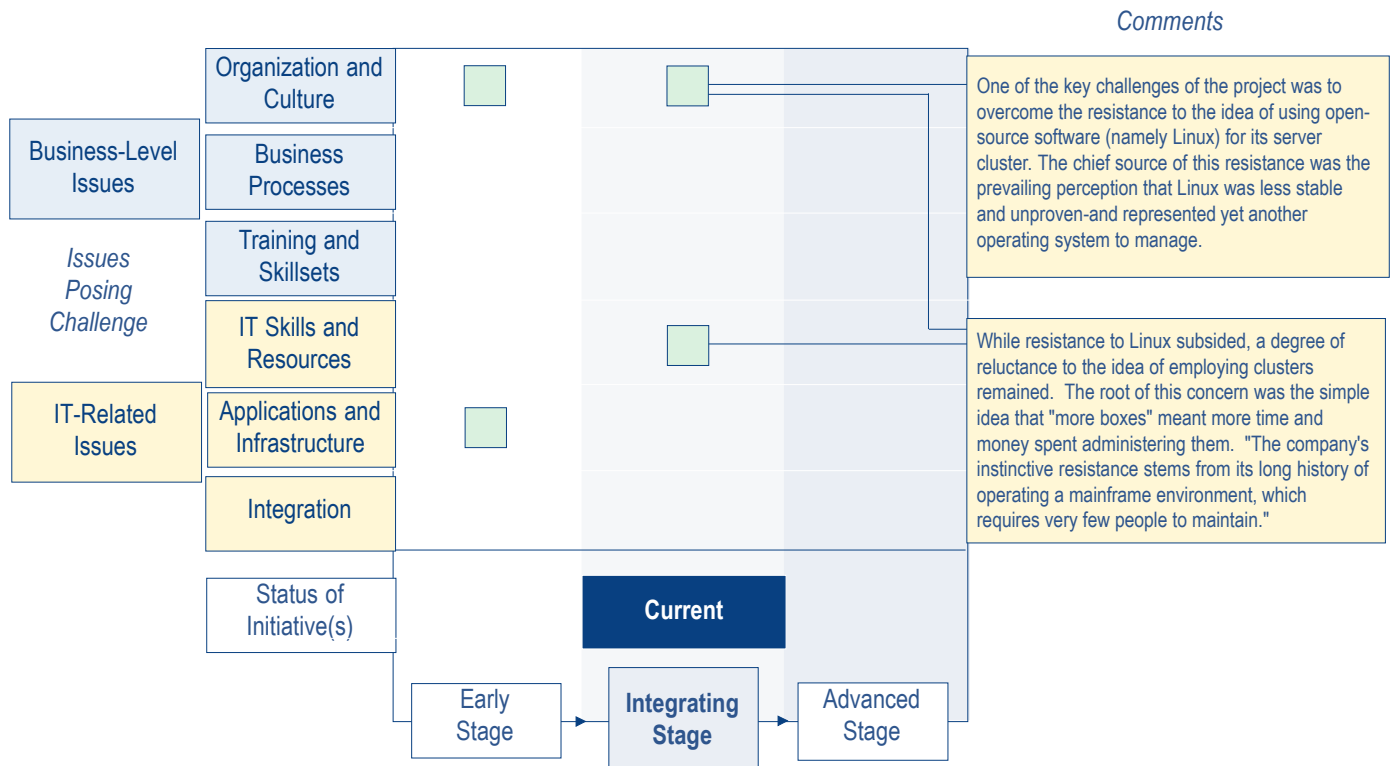
ture, we naturally saw load balancing as critical to the performance, scalability, and availability of the solution,” he notes. “Working together, WebSphere Edge Server and Application Server allowed us to optimize the performance of the solution.”

Because the interaction of front-end Java-based applications and MAN’s backend systems is central to the solution’s functionality, the choice of a messaging middleware platform was of critical importance. The fact that MAN maintains a highly diverse IT environment made this integration especially challenging. In addition to an IBM eServer zSeries (formerly S/390) running its core applications, MAN’s legacy environment includes servers running HP-UX, Solaris, Windows NT and Tandem. Dr. -Ing Lorenz cites this heterogeneity in pointing out the need for a flexible, standards-based product—and how IBM WebSphere MQ met the need. “We saw support for standards as being highly beneficial for our future integration efforts,” he says. “The stability and maturity of WebSphere MQ—along with its very good execution of the JMS (Java Messaging Service) standard—made it a clear choice for us.” In addition to IBM WebSphere MQ, MAN evaluated BEA Systems’ MessageQ™ product.

Challenges

For Dr. -Ing Lorenz and his team, one of the project’s key challenges was establishing the acceptability of using open-source software (namely Linux) for its server cluster. At the time of the decision, the tide of opinion within MAN’s IT organization favored Windows NT and HP-UX, largely on the basis of

Challenges Encountered in MAN’s e-business Evolution



Source: MAN Nutzfahrzeuge and IDC

experience with these operating systems. Apart from stiff competition, Linux faced resistance for a number of reasons. Foremost among them was the perception within management that Linux was not commercially supported, less stable and unproven; it also represented yet another operating system to manage. Dr. -Ing Lorenz's team countered these objections by pointing out how Linux enabled companies to employ clusters of smaller, less-expensive servers—thus saving on hardware costs. He further strengthened the case for Linux by building a prototype environment that employed four Intel servers to test the concept in a demanding, “worst-case” setting. After it was determined that the prototype provided better stability under heavy processing loads and proved easier to manage, the merits of Linux became clear.

While resistance to Linux subsided, a degree of reluctance to the idea of employing clusters remained. As Dr. -Ing Lorenz explains, the root of this concern was the simple idea that “more boxes” meant more time and money spent administering them. “The company’s instinctive resistance [to multiple servers] stems from its long history of operating a mainframe environment, which requires very few people to maintain,” he explains. “We allayed this concern by showing how the system would enable us to centrally administer all the nodes of the cluster with no increase in manpower required.” The efficiency of this management scheme—made feasible by the use of identical servers in the cluster—was both clear and compelling.

Solution Profile and Implementation Strategy

The Solution: Core Functionality and Architecture

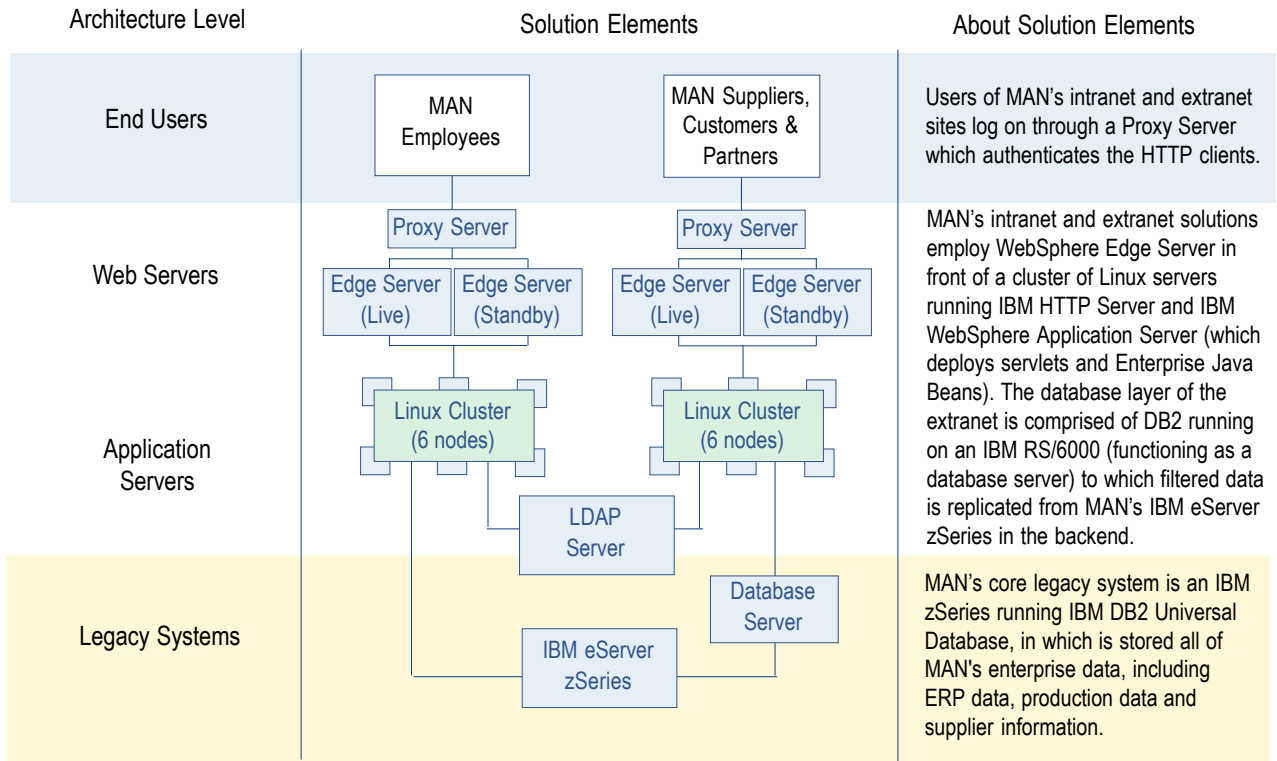
MAN's new e-business infrastructure is comprised of three discrete segments (i.e., subnets), defined as:

- *Intranet*—Accessed by MAN employees, applications range from basic data searching to Knowledge Management, Data Warehousing and ERP.
- *Extranet*—Accessed by customers, suppliers, distributors, dealers and other MAN business units, applications include data sharing, collaboration, and online transactions.
- *Public Internet*—Accessed by general public, primarily includes the presentation of company and product information.

MAN's infrastructure is defined by its use of identical architectures for its intranet and extranet solutions. Under this arrangement, all mission-critical data is stored in databases (including IBM DB2 Universal Database) within the company's intranet subnet. Data accessed by extranet users is filtered from the intranet databases and replicated (using the Replication Management tool within IBM DB2) out to extranet databases. This approach—rooted in MAN's desire to maximize the security of its core data—enables most extranet users (those who do not require realtime data) to access data without passing through its firewall.

The intranet and extranet solutions employ a four-tier architecture. At the

Basic Architecture of MAN's Intranet/Extranet Solution



Source: MAN Nutzfahrzeuge and IDC

front end (tier one) are two Linux servers running IBM WebSphere Edge Server V2.0 (one live, one on hot standby) used for load balancing and failover. Just below this, in the second tier, are a cluster of six Linux servers running IBM HTTP Server, WebSphere Application Server (Advanced Edition V3.5) and DB2 Connect Server. The load balancing servers pass user requests for HTTP, DB2 Connect Server and Enterprise Java Bean (EJB) applications to the second tier's servers; WebSphere Application Server running in the second tier deploys Java-based Web applications. The third tier of the solution, an LDAP Server, provides administrative security for WebSphere Application Server.

The fourth tier of the architecture—the database layer—varies between the intranet and the extranet portions of the solution. For the intranet portion, the chief component of this layer is comprised of an IBM zSeries running IBM DB2 Universal Database, in which is stored all of MAN's enterprise data (including ERP data, production data, supplier information, and MAN's data warehouse data). By comparison, the database layer of the extranet is comprised of DB2 running on an IBM RS/6000 functioning as a database server. This extranet database is populated by filtered data, replicated from MAN's mainframe (i.e., intranet) databases. Up in the second tier of the solution, EJB applications and servlets (enabled by WebSphere Application Server) access these fourth-tier databases and a number of legacy mainframe applications through WebSphere MQ queues, JDBC and SQLJ.

Security Profile

As discussed, one of the core elements of MAN's security architecture is the use of data replication from mainframe databases to the extranet's database server to make it unnecessary for extranet users to cross the intranet firewall. As Dr. -Ing Lorenz explains it, "the main goal of the replication approach is to have the maximum level of security within MAN's applications and data." MAN maintains several firewalls: between the Internet and the extranet; between the Internet and the intranet; and between the intranet and the extranet. Another element of MAN's security architecture is the use of a reverse proxy server, under which WebSphere Application Server accepts and processes HTTP requests that come through the proxy server rather than directly from the HTTP client. The proxy server authenticates the HTTP clients and passes authenticated requests to WebSphere Application Server, which authorizes access to the requested resources based on the application's authorization policies. SSL is used for encryption between the proxy server and the client, and between the proxy server and WebSphere Application Server.

MAN's Solution in Action

Chemical engineers from MAN's materials research department approve and certify lubrications and service products for MAN's commercial vehicles and industrial engines. This data is needed by all dealers' garages providing service for MAN's commercial vehicles worldwide. The engineers manage their data with a customized front end interface in the lab. This interface is

The screenshot shows a Microsoft Internet Explorer browser window displaying a web page from MAN Nutzfahrzeuge AG. The page title is "Approved Service Products for Commercial Vehicles and Industrial Engines". The browser address bar shows the URL: <http://manwww04/webapp/tucnbt/index.xml?sessionId=50C530FWUG5Z3MKS3ANTWMY>. The page content includes:

- Navigation buttons: Zurück, Vorwärts, Abbrechen, Aktualisieren.
- Language selection: Deutsch (with German flag).
- Text: "Choose one of these possibilities:"
- List of options:
 - [Specification](#)
 - [Brand name](#)
 - [Manufacturer](#)
- Text: "Application forms for approval:"
- List of application forms:
 - [Engine oils](#)
Form TUCN 13.010 (PDF-File)
 - [Gear oils and ATF](#)
Form TUCN 13.024 (PDF-File)
- Text: "Last update: 2002-07-04"
- Text: "Accesscounter: [308] ?"
- Contact information:

Contentqueries:
MAN Nutzfahrzeuge AG, Ursula Jäger
ursula_jaeger@mn.man.de
Tel.: +49 911 420-2005, Fax: +49 911 420-1920

linked via ODBC to an IBM DB2 database where all relevant data is stored. As soon as the tested products are approved, DB2's replication mechanism is activated from within the front-end application. With that, all modified data is replicated to the main intranet DB2 database (at MAN's Munich plant), where a database trigger will automatically push data for public access over the firewall to the DB2 extranet database.

Suppliers, customers or employees can access Web pages to search and retrieve product information. During searches, results are represented as either XML files, HTTP pages or PDFs. Search requests are handled by a Java servlet, which retrieves the data from the DB2 database via JDBC and produces an XML file. The XML file can then be delivered over the Web and integrated within suppliers' backend systems ("system-to-system") or translated into HTTP or PDF via an XML/XSLT Transcoding server (browser-based access).

The Project: Development Approach and Timetable

After completing the technical proof of concept implementation of the Linux cluster architecture in August 2001, MAN spent nearly two months testing under very high loads. After successfully completing testing of the environment in October 2001, MAN began procuring the hardware used in the Linux clusters and putting the necessary networking in place. The development of EJB applications and servlets—performed by MAN internally using IBM WebSphere Studio and WebSphere Studio Application Developer (formerly VisualAge for Java)—was completed by the end of December 2001.

Development Timetable for MAN's e-business Solution

	March 2001	July 2001	August 2001	October 2001	December 2001
MAN begins needs study designed to flesh out and assess its e-business requirements and capabilities.	■				
MAN completes its technology and vendor selection process, choosing Linux and IBM WebSphere Application Server as the core of its platform.		■			
MAN completes the technical proof-of-concept implementation of the Linux cluster architecture.			■		
MAN successfully completes the testing of the solution prototype; begins procuring and deploying infrastructure.				■	
MAN completes the development of the solution.					■

Source: MAN Nutzfahrzeuge and IDC

Business Results

MAN's goals in moving to a tiered, cluster-based architecture were centered around achieving major improvements in operational efficiency in a cost-effective way. One of the most immediate benefits MAN achieved was easier systems administration, including the ability to service and upgrade its infrastructure while providing users with 24 by 7 availability. But over the long haul, Dr. -Ing Lorenz expects the ability to scale the system at low cost to emerge as the most compelling value proposition of the Linux-based cluster-based model. "We expect the volume of MAN's e-business activity to continue rising as we introduce more services to our customers, partners, suppliers and employees," he says. "The inherent scalability of our new infrastructure puts us in a much better position to adapt as our needs evolve, while at the same time keeping our additional hardware and management costs to a minimum."

Dr. -Ing Lorenz also counts performance improvements among its key benefits, much of it attributable to the solution's load balancing features. "We've been very pleased with WebSphere's load balancing features," he notes. "They've led to marked improvement in the solution's performance, stability and overall quality of service." He also sees the embrace of WebSphere Application Server having a major positive impact on MAN's application development and management processes. "The WebSphere platform has enabled us to stream-

Overview of MAN's Business Results Achieved

Business Process Area/Issue	Nature of Benefit	Description or Metric
Systems Administration	More Flexible Systems Management Capability	Moving to a cluster-based architecture has given MAN the ability to service and upgrade its infrastructure while providing users with 24 by 7 availability.
Infrastructure Scalability	Simple, Cost-Effective Upgrade Path	MAN's cluster-based architecture allows the company to expand its capacity by adding cost-efficient servers on an as-needed basis.
Infrastructure Performance and Reliability	Improved Overall Performance	WebSphere's load balancing features have provided MAN with a marked improvement in the solution's performance, stability and overall quality of service.
Application Development and Management	Lower Costs and Faster, More Flexible Processes	MAN's embrace of the WebSphere platform has allowed it to streamline and better define its software development process, putting the company in a stronger position to develop, deploy, integrate and manage dynamic e-business applications.

Source: MAN Nutzfahrzeuge and IDC

line—and better define — our software development process,” he adds. “This puts us in a stronger position to develop, deploy, integrate and manage dynamic e-business applications.”

Case Epilogue

With the project judged a resounding success, MAN continues to chart the evolution of its e-business infrastructure—as exemplified by its recent piloting of a Web Services initiative. Begun in late 2001, the initiative was designed to allow MAN to expose an existing collaborative intranet application to customers and partners. This application, now in pilot stage, allows MAN to securely share design documents with manufacturers of aftermarket equipment to ensure that their designs comply with MAN’s vehicle specifications. As Dr. -Ing Lorenz points out, the ability to repurpose its intranet application for extranet users allows MAN to avoid the cost of deployment as well as added management costs. “MAN’s new infrastructure has already allowed the company to gain more leverage from its base of IT assets,” he says. “We see Web Services as extending that ability to leverage even further. By supporting standards like XML, J2EE and SOAP, the WebSphere platform has opened the door for us to begin to explore Web Services.”

08-02

DB2, DB2 Universal Database, DB2 Connect, IBM, the IBM logo, MVS, RS/6000, S/390, VisualAge, WebSphere and zSeries are trademarks or registered trademarks of International Business Machines Corporation in the United States, other countries or both.

Java, all Java-based trademarks and Solaris are trademarks of Sun Microsystems, Inc. in the United States, other countries or both.

Linux is a registered trademark of Linus Torvalds.

Windows NT is a trademark of Microsoft Corporation in the United States, other countries or both.

UNIX is a registered trademark of The Open Group in the United States and other countries.

Other company, product, and service names may be trademarks or service marks of others.