



HP NonStop Advanced Architecture

A business white paper

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Executive summary

Since its inception in the mid-1970s, the HP NonStop server has held an important role in helping global business run smoothly, effectively, and successfully. Today, NonStop servers process the overwhelming majority of credit card, automated teller machine (ATM), and securities transactions. The world's leading enterprises rely on NonStop servers, including 106 of the 120 largest stock and commodity exchanges and 135 public telephone companies. Innovative solutions based on the NonStop platform help customers achieve competitive advantage in multiple industry sectors, including financial services, telecommunications, healthcare, retail, public sector, and manufacturing. Based on studies by The Standish Group, the NonStop server delivers the lowest total cost of ownership (TCO) in the industry for servers of its class.

The introduction of the HP Integrity NonStop server, based on the Intel® Itanium® processor and the HP NonStop Advanced Architecture (NSAA), takes this powerful technology to a new level. Building on a tradition of industry-leading availability, scalability, and data integrity, this new platform delivers the highest level of application availability with fail-safe data integrity.

The Integrity NonStop server based on the NSAA raises the bar by improving all the fundamental benefits of previous NonStop servers in the following areas:

- Software fault tolerance
- Hardware fault tolerance
- Scalability from 2 to 4,080 processors
- Scalability to 65 TB of main memory
- Online database and application manageability
- Query processing while maintaining transaction response times
- Data integrity
- Leverage of industry standards in hardware and software

All of these features are available out of the box and drive the cost of developing and managing the most demanding business applications to the lowest levels in the industry.

This business white paper describes the features and benefits of the HP Integrity NonStop server, which is built on the NonStop Advanced Architecture, and forms the foundation for the Integrity NonStop server. The paper also provides examples of the types of applications that will benefit from this new architecture by driving new levels of service for the world's most demanding business-critical applications. When user service levels are paramount, customers can trust the Integrity NonStop server for their most critical business applications—at price points not previously thought possible.

Business challenges

As the global economy continues to force enterprises to become even more competitive, there is increasing pressure to build information technology infrastructures that enable the highly cost-effective and flexible deployment of business-critical applications. CIOs and IT managers are expected to drive business results, help the company meet profitability and growth targets, expand into new markets, and improve customer experience. IT, which plays one of the most critical roles in driving business success, must constantly balance multiple—and sometimes conflicting—objectives while dealing with a dynamic business environment:

- Maximize total return
- Mitigate risk to the business

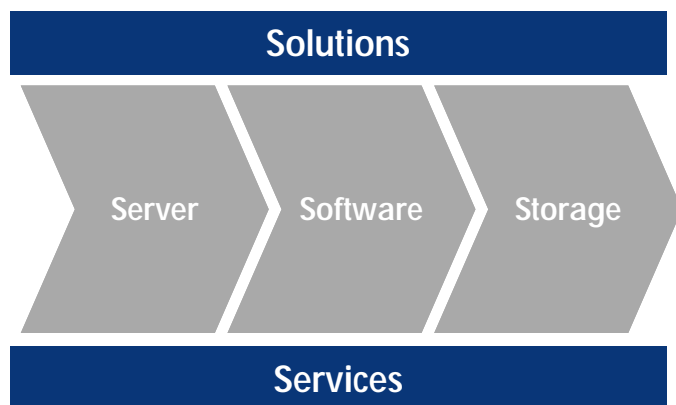
- Improve systems and business performance
- Increase the company's agility

At this enterprise level, HP has created the Adaptive Enterprise strategy, focused on synchronizing business and IT to leverage change for competitive advantage. HP's Adaptive Enterprise strategy focuses on helping businesses lower IT-related costs while making IT flexible enough to deliver what business managers really want and need. In today's business world, change is a constant—and the most successful companies are those that embrace and capitalize on change. They do it by ensuring that their IT systems are flexible and can adapt in real time to rapidly changing business conditions.

At the heart of many Fortune 1000 enterprises is a NonStop server that supports dynamic real-time business requirements in which application downtime is not an option and flexibility is essential. As everywhere else, there is pressure in this mission-critical arena for even higher levels of service at a significantly reduced cost. This is precisely the impetus behind the NonStop Advanced Architecture, which delivers high levels of application availability with failsafe data integrity—complemented by virtually unlimited scalability—to satisfy the world's most critical computing requirements.

The NonStop Advanced Architecture

Figure 1. NonStop Advanced Architecture (NSAA)



The NonStop Advanced Architecture (NSAA) is an evolutionary approach to improving the original and well-established NonStop system architecture. The NSAA encompasses the new HP Integrity NonStop server, related NSAA database and transaction processing software, and the ability to deploy advanced storage area network products from HP's StorageWorks product family. A comprehensive suite of services is available in these three areas to enable customers to fully leverage the Integrity NonStop server, HP's premier platform for meeting the most stringent service-level requirements.

The basic framework of the NSAA is shown in figure 1.

NSAA provides customers with the highest levels of availability and scalability in the industry with significantly improved price/performance, while providing a foundation that is agile and ready to meet the business requirements of today and tomorrow. To help achieve this objective, HP chose to adopt the industry-leading 64-bit microprocessor from the Intel Itanium processor family.

The Itanium processor family

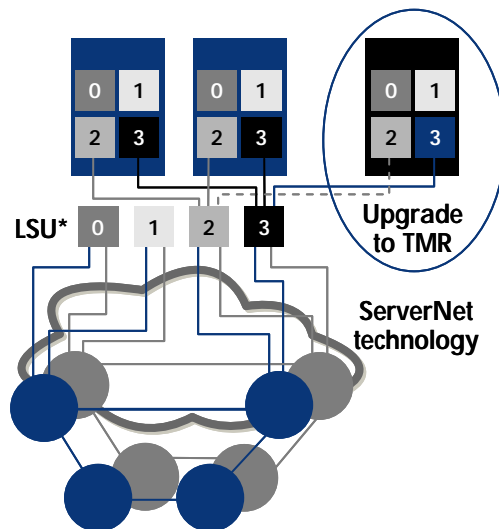
The Itanium processor delivers the best performance for enterprise-level workloads today, and Intel is investing heavily in the future of the Itanium processor family; for example, Intel will soon introduce the ability to have multiple microprocessors on the same die, which will significantly improve the performance delivered from the same footprint. A key benefit of moving to the NSAA for HP NonStop system customers, therefore, is that the Integrity NonStop platform is now able to take advantage of Intel's aggressive Itanium product roadmap. This will enable HP to deliver successive improvements in the price/performance of the Integrity NonStop server.

The Intel Itanium processor delivers advanced parallelism, scalability, and reliability for enterprise-level applications and databases. All new Itanium processors deliver lower cost, increased flexibility, and greater choice than proprietary RISC-based solutions. The Itanium processor family brings the advantages of volume economics into the high-end computing environment.

Intel bases its business model on broad collaboration and high-volume manufacturing. Development work on several new processor generations, and Intel continues to deliver on its goal of increasing processor and price performance. The Itanium processor family makes it possible to build high-end computing solutions using powerful, flexible, and affordable industry-standard building blocks. The key point is this: The Itanium processor family is both industry standard and industry leading, and it brings important benefits to the new Integrity NonStop server.

HP Integrity NonStop server

Figure 2. The NonStop Blade Complex using NonStop Advanced Architecture for Integrity NonStop servers



* Note: LSU = logical synchronization unit

The NonStop Blade Complex within Integrity NonStop servers, with both Dual Modular Redundancy (DMR) and Triple Modular Redundancy (TMR) configurations, is shown in figure 2.

To attain the objective of improved hardware availability at significantly better price/performance in the Integrity NonStop server, HP decided not only to adopt the Intel Itanium processor but also to take advantage of HP's considerable experience in building servers utilizing this technology. HP was able to use some processor components from its Integrity family of servers in an innovative way to deliver a flexible, fault-tolerant capability. At the same time, the adoption of standard components helps deliver a stable product at reduced cost to the customer.

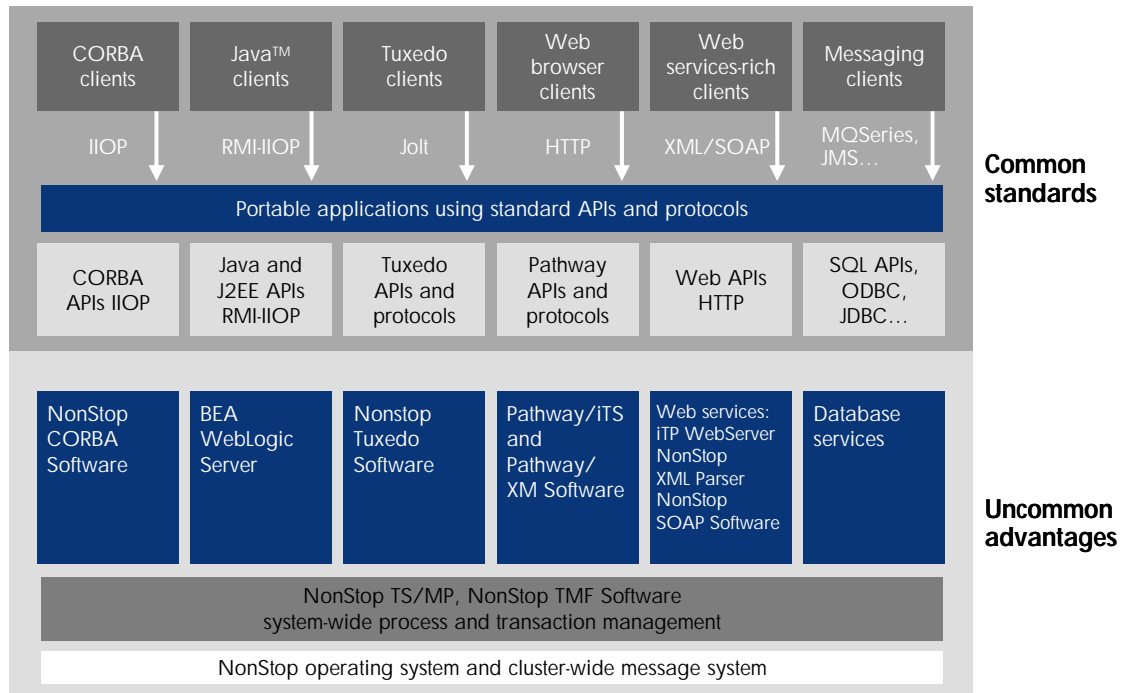
The key capabilities that users demand from their mission-critical systems are fail-safe data integrity, zero downtime, scalability, and investment protection. To achieve these capabilities, the HP NonStop Integrity server uses 4-CPU processor boards similar to those used in other Integrity servers, which are called **NonStop Blade Elements**. Two of the NonStop Blade Elements are taken and connected together with an innovative technology called the logical synchronization unit (LSU). The Blade Elements and associated LSUs are called the **NonStop Blade Complex**. The output from the LSU represents a logical processor. There are four modules in each LSU that provide the synchronization between two of the CPUs. If either CPU fails or the LSU module fails in this configuration, the work being done in the logical processor is taken over by the remaining processors in the system. The LSU takes inputs from multiple microprocessors and checks to see if the results are identical for each I/O request. This “loosely coupled” lockstep allows the server to leverage the self-checking capabilities of the Itanium processor while achieving improved performance.

For optimum availability to satisfy business requirements, users can choose either the Dual Modular Redundancy (DMR) or Triple Modular Redundancy (TMR) models. The DMR configuration, which has two lockstepped Itanium processors (described above) performs similarly to previous NonStop servers by allowing a system to survive most failures. The new architecture also allows for a TMR model with three loosely coupled Itanium processors. This TMR configuration significantly improves the hardware availability of the Integrity NonStop server, which remains fault tolerant in the event of a failure and can also handle multiple failures. With the modular design of the Integrity NonStop server, users can alter the configuration from a DMR to a TMR on site to meet their needs as business requirements change.

Another key feature of the Integrity NonStop server is its ability to scale an application to more than 4,000 Itanium processors easily, without user interruption. This is done by leveraging the high throughput of the HP ServerNet interconnect fabric. ServerNet technology facilitates communication across all system resources. As an expandable switching fabric, it does not suffer from limited bandwidth. The modular enclosure, which uses standard 19-inch racking to optimize floor space, also allows customers to add components readily. The ease with which this level of scalability can be attained protects existing investment and supports a growing and dynamic business environment.

NonStop software

Figure 3. NonStop software combines industry-standard technologies with the uncommon advantages of the NonStop server platform



A major benefit of the new NSAA is that it inherits all the capabilities of the traditional NonStop software architecture that have been production proven over the last 30 years. Key in this area are the database and transaction processing services that facilitate applications scaling across many thousands of processors. HP has preserved the same application program interfaces (APIs) in the Integrity NonStop server, making it straightforward to transition customer and ISV applications onto the new platform. Also, the complete software fault-tolerant environment of previous NonStop servers is identical in the new platform.

The application programmer and system manager do not need to concern themselves with the underlying software stack. They can utilize the services provided by using industry-leading and standard interfaces. Manageability tools such as HP OpenView and Systems Insight Manager Software are available to control the Integrity NonStop server environment. Application interfaces such as BEA WebLogic, Java™, C++, ANSI SQL, CORBA, and Tuxedo are available (see figure 3). Thus, applications can be developed in a common environment while leveraging the uncommon advantages of software fault tolerance and scalability to more than 4,000 CPUs.

In any system, the software that supports such complex application environments can experience processor-crashing bugs through a unique set of software actions that combine to create an untested and unexpected environment. These "Heisenbugs," as they are often called, are likely to exist as long as the processor power continues to increase and software becomes even more sophisticated.

Integrity NonStop server software supports the failure of a logical processor (either DMR or TMR configuration) and the subsequent takeover of its functions by other processors in the system. This activity is facilitated in two ways:

- First, HP creates the lower levels of software (operating system, database, and transaction processing services) to use the low-latency message system that keeps each of two system processors aware of what the other is doing. In the event of a failure of a logical process, a second processor takes over from the first at the last “checkpoint” transmitted between them. This uses patented technology called **process pairs**, which is transparent to users and application programmers.
- Second, in the event of a logical CPU failure (DMR or TMR), the operating system, database, and transaction processing services will, through the mechanism described above, survive the failure. They will then recreate any application code that was running in the failing CPU in a remaining processor. That code will reference log files to ascertain the state of its unit of work at the time of the crash, and continue from where it left off. Again, as with the process pairs technology, this is transparent to users and application developers.

Both of these processes virtually eliminate downtime from software bugs. The above, described as “software takeover,” has been the foundation of the HP NonStop server since the mid-1970s. This well-tested and tried technology is still unique in the industry. It is further complemented by world-class online manageability features of database and transaction processing services that minimize planned outages.

This paper will address in detail the subject of reducing planned outages, but the reader should understand that the Integrity NonStop software environment is again world class in this respect, and it is a vitally important part of the overall application availability puzzle.

With both the DMR and TMR configurations, no software failover will occur in the event of a hardware failure; there is always a remaining Blade Element to support the continued running of the low-level software (and therefore, the applications) in that processor. This paradigm differs from previous generations of NonStop processors, in which any CPU hardware failure would result in a software takeover. Because the NSAA does not invoke software takeovers as frequently, overall system availability is increased.

Another design point of the NonStop software environment is the ability to partition data across all available disks. This powerful feature makes it possible for application objects and entities in different processors to access data in different file or database partitions in parallel, significantly reducing the time needed to perform tasks such as large queries. This also makes it possible to handle large transaction volumes with little impact on response times.

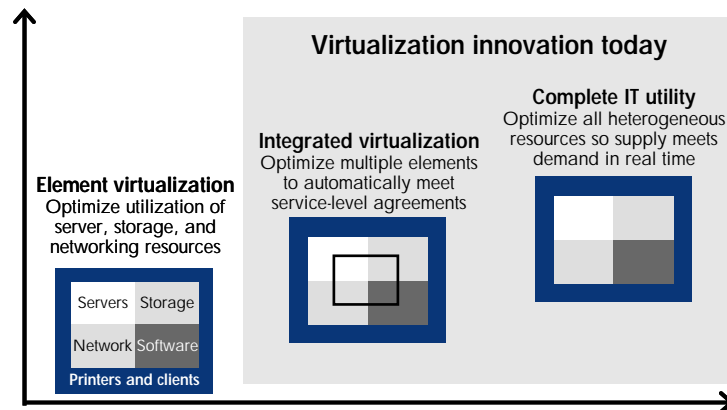
In summary, to deliver the only software fault-tolerant server in the marketplace, HP uses the following patented technologies within the NSAA:

- Message-based operating system
- Geographic independence of resources
- Process pairs
- Parallel processing

Application Virtualization for the HP Integrity NonStop server

HP offers a broad spectrum of virtualization solutions that allows customers to choose the most appropriate path and optimization focus for their IT infrastructure resources. Customers today employ a number of IT optimization strategies, which include varying degrees of virtualization (see figure 4). HP defines these strategies in the following terms.

Figure 4. Virtualization innovation



Application Virtualization for the Integrity NonStop server as part of the NSAA is a prime example of integrated virtualization, where the resources in an NSAA server are optimized to support significant growth with stringent service-level agreements. Application Virtualization defines a set of hardware and software features designed to optimize resources at the application level, simplifying the deployment of highly available and scalable applications based on the proven clustering capability of NonStop systems.

Many of these features have been available for some time on the HP NonStop S-series platform; with the introduction of the NSAA, however, HP is delivering this set of features with pricing that supports flexible deployment, with no extra charge for this built-in capability. As the industry evolves toward true utility computing over time, HP will develop more features to support this well-differentiated capability.

Storage

The Integrity NonStop server supports the modular HP StorageWorks XP12000 Disk Array. The XP12000 Disk Array is designed for organizations that demand the most from their storage and delivers 24 x 7 availability. The fact that it provides no single point of failure and a scalable design enables customers to meet their capacity, performance, and heterogeneous connectivity needs today and tomorrow. Outstanding levels of random and sequential performance are ideal for database and online transaction processing (OLTP) workloads. World-class service and support meets customers' most demanding needs.

The breadth of the XP12000 Disk Array's capabilities allows customers to demand more agility to adapt to real-time business needs, more value by verifying that information is protected and available, and more simplicity by reducing costs through consolidation and management efficiency.

Features and benefits of the XP12000 Disk Array:

- **Reliable:** Provides extreme reliability with no single point of failure
- **Available:** All components are redundant and hot-swappable
- **Scalable:** Scalable to 165 TB of internal capacity, 14 PB of external capacity, and 128 GB of cache
- **Performance:** Uses an advanced crossbar fault-tolerant architecture, resulting in outstanding levels of random and sequential I/O operations for database and OLTP workloads
- **Heterogeneous:** Supports multiple operating systems
- **Open Connectivity:** Supports Fibre Channel, FICON, and ESCON connectivity
- **Flexible:** Supports a mixture of disk drives configured as RAID 1 and RAID 5
- **Manageable:** Multiple arrays and hundreds of terabytes can be managed from a single station with no increase in staffing
- **Value:** Excellent price/performance ratio, increased productivity through higher throughput speeds and zero downtime, and compact footprint to conserve floor space

Services

HP Services, the experts in NonStop technology, can help ensure that transitioning to the Integrity NonStop server goes as smoothly as possible, avoids any unplanned downtime, and does not overburden customers' internal resources. Three key services are available to assist in planning and building a successful evolution to the Integrity NonStop server:

- **Evolution Assessment Service**—This service helps customers develop a detailed understanding of the requirements for a successful move to the Integrity NonStop server. Key areas of focus include business-critical applications and their interface with other IT components. An HP Services expert performs a technical assessment of the current environment to identify all areas that must be proactively addressed for a successful and efficient evolution.
- **Evolution Infrastructure Planning and Design Service**—HP assists customers in building a success-oriented strategy and plan for evolving to the Integrity NonStop platform. HP Services professionals work with the customer to develop a detailed project plan that addresses all domains of the IT and business environment. This involves a global approach, with a clear focus on gaining the greatest benefit from the evolution while avoiding any negative impact on business processes and personnel.
- **NonStop Service Solutions**—The challenge for IT is to efficiently implement a business solution that provides operational excellence and meets the required levels of availability for the end customer. HP NonStop Service Solutions provides quick installation, customized configuration, rapid startup, and NonStop educational services—as well as the recommended level of support—all in one package.

HP Services takes an end-to-end approach to the life cycle, enabling customers to be flexible in moving forward to the Integrity NonStop platform at the pace that fits their needs.

Business solutions

The new NSAA provides the industry-leading platform for the deployment of applications that demand the highest service levels. Target markets for such applications include financial services, telecommunications, public sector, healthcare, and manufacturing.

Financial services

The most pervasive financial applications on the NonStop platform are those that serve retail and wholesale banks and the capital markets. These applications are deployed in more than 600 financial institutions today. In addition, HP has developed an open, standards-based framework called HP Adaptive Bank to enable customers to deliver world-class cost structures, focused innovation, and a flexible and adaptive approach to the delivery of banking services.

Real Time Financial Services (RTFS), an implementation of the HP Adaptive Bank architecture on the NonStop platform—and now the Integrity NonStop platform—gives financial institutions real-time visibility of critical business processes and customer interactions, no matter how complex their business environment may be. The solution addresses the standing problem of integrating data from disparate delivery channels, point-to-point interfaces, applications, operational data stores, and electronic data interchange (EDI) methods across the enterprise.

With the HP Adaptive Bank architecture and RTFS, each channel has access to a current, consolidated view of customer and business data, enhancing the power of existing applications and protecting IT infrastructure investment. The result: an ideal service-oriented architecture, in which the infrastructure becomes an asset that enables the future strategy of the bank.

Network Service Providers

Network Service Providers (NSPs) provide another major industry sector in which the NonStop server has a well-recognized and highly respected presence. HP develops solutions for NSPs, and several of these solutions are based on the NonStop server, notably the Home Location Register (HLR) and Location Based Services (LBS). HLR and LBS provide the necessary infrastructure for deploying large-scale wireless networks for cellular phones and other services. HP has transitioned these key solutions to the Integrity NonStop server, making it possible for HP to offer high levels of service with the ability to grow these solutions linearly as more subscribers are added.

Solutions include messaging, billing, revenue assurance, and network services such as HLR and location. NonStop servers are the de facto standard whenever there is a need for powerful, high-end servers to run business-critical and mission-critical applications. HP has focused its development resources, along with those of our key partners, on providing solutions that can meet operational requirements for 24-hour, 365-day service and the ability to support expanded transaction volumes as business grows.

In the area of real-time solutions for this industry, HP has developed the Dynamic Data Manager (DDM). DDM will enable NSPs to integrate their networks and/or customer data in real time, allowing them to offer new services to their customer base more quickly. The transition to the Itanium processor is welcome because of the extra power that can be brought to bear on the solution for much lower cost.

Public sector

In the public sector arena, the NonStop server has been utilized primarily in federal government solutions (for example, Singapore's homeland security application) to date. With the advent of the Integrity NonStop server, however, HP is collaborating with an important new partner, SimDesk Technologies, Inc., to bring computing capability to a much broader audience. The ability to bridge the digital divide—to lessen the gap between the technology “haves” and “have-nots,” and allow all segments of society to benefit from advanced technology—is a worthy and long-held goal. SimDesk software on the Integrity NonStop platform carries the potential to transform both business and society.

With a full suite of software and services, from word processing to spreadsheet, groupware, and messaging programs, this innovative solution can turn every public computer terminal into a point of access to a community-wide virtual network. In many ways, SimDesk represents a new paradigm: ubiquitous, portable, low-cost computing, delivered on a massive scale with enhanced security features. According to Louis Waters, chief executive officer of SimDesk, this idea of community computing is the best example of utility computing in place today. “We're putting the utility model to work on a massive scale to bridge the digital divide in large cities and states right across the globe,” says Waters. Driving this engine requires significant processing power, and HP and SimDesk have agreed to use NonStop servers as the computing platform for SimDesk technology. The State of Indiana, with its “SimIndiana” project, is the first major SimDesk customer to use the Integrity NonStop server.

Healthcare

The healthcare market is another area in which the unique capabilities of the Integrity NonStop server can deliver true competitive advantage. NonStop system capabilities focus on three primary solution areas: Carecast, a partner-driven solution for patient care from IDX; a real-time Electronic Healthcare Record (EHR) solution; and a clinical analytics solution.

Carecast is IDX's next generation of electronic clinical information solutions, delivering unsurpassed response time and reliability to support fast-paced clinical environments. The system automates workflow throughout the healthcare enterprise and enables rapid access to patient records across the care continuum, from admission to discharge, including pharmacy and ambulatory care. Carecast is a fully integrated clinical, financial, and administrative system, combining core clinical processes for orders, results, pharmacy, and clinical documentation with administrative and financial processes for scheduling, registration, admitting, charging, and billing. The result is a comprehensive lifetime patient record that enhances the quality of care and promotes operational efficiencies.

A real-time Electronic Health Record (EHR) system enables evolutionary use of the health information infrastructure across hospitals, geographic regions, states, and countries. HP's approach, running on the proven HP NonStop server platform, brings the highest levels of performance, availability, and reliability to the healthcare infrastructure. Based on the patented HP Zero Latency Enterprise (ZLE) architecture already in use in other industries (including retail, finance, and telecommunications), HP's approach to EHR enables integration and aggregation of an individual's lifetime summary of health records, with links to detailed information wherever it resides. This approach reduces the risk of mistakes and adverse events by presenting a single, holistic view of the patient's current health and health history to clinicians and practitioners. It reduces errors and duplicate treatments, as episodes of care can be tracked across all health services. It improves continuity of care and delivers a real-time view of health events across the region for disease control and resource planning.

A new area of healthcare management that is gaining in importance is clinical data analysis. This entails making the enterprise information model as intuitive, flexible, granular, and extensible as possible in order to meet the burgeoning data demands of increasingly sophisticated outcomes research. The use of this technology allows the facilitation of evidence-based medicine, which can

provide outcomes-based means for discovering new best practices. It also enables automated data collection and reporting for Centers for Medicaid and Medicare Services (CMS) and satisfies other pay-for-performance reporting requirements. The result is an informatics capability that is useful at all levels of the organization. This includes the delivery of executive dashboard monitoring of key performance indicators, with information based on consolidating clinical data from several legacy operational source systems under one enterprise information model adapted for analytics.

Manufacturing

HP has many proven solutions in the manufacturing sector; for example, the company has been very successful selling its NonStop servers into the European car manufacturing arena, with customers such as DaimlerChrysler and Porsche.

Recently, HP worked with its partners to develop a Real Time Supply Chain (RTSC) solution that enables the integration of supply chain information in real time. Because the solution uses business rules, it can significantly improve real-time decision making to improve supply chain performance. RTSC, a powerful complement to the HP Supply Chain portfolio, simplifies the real-time integration of multiple applications, versions, and data, offering customers a single, up-to-the-second view of their entire supply chain.

RTSC includes adapters for major enterprise application integration (EAI) solutions, including SAP Exchange Infrastructure, a main element of SAP NetWeaver. The combination of RTSC and NetWeaver is the most powerful solution today for real-time enterprise integration across heterogeneous IT landscapes, providing HP and SAP customers with lower total cost of ownership, better leverage of existing IT investments, and a comprehensive foundation for innovative cross-enterprise processes to build an Adaptive Enterprise.

Summary

The introduction of new servers, software, storage, and services, along with the powerful and flexible NonStop Advanced Architecture, offers the marketplace the best platform for delivering the highest application service levels at the lowest total cost of ownership, with very rapid return on investment.

The new Integrity NonStop platform not only capitalizes on the proven traditional NonStop capabilities, but also extends them in a new, open paradigm. This will enable a larger market to experience the benefits of the Integrity NonStop server and the Intel Itanium processor family. When user services levels are paramount, customers can trust the Integrity NonStop server for their most critical business applications.

For more information on the HP NonStop Advanced Architecture, visit www.hp.com/go/nonstop.

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