INFORMATION TECHNOLOGY
INTELLIGENCE CONSULTING

Intel Xeon Processor E7 Family Reaches Reliability Parity with RISC/UNIX, Delivers 99.999% Reliability, Availability and Serviceability

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Table of Contents

Executive Summary

There is no such thing as acceptable downtime.

Today's networks run 24/7 and often have a global footprint. End users, customers, business partners and suppliers expect network data and services to be "always on," available and accessible from anywhere. Businesses require the most optimal levels of reliability, availability and serviceability (RAS) for their mission-critical hardware, applications and services in physical, virtual, clustered and cloud environments. Even a few minutes of downtime can disrupt network operations and result in losses that range from thousands to millions depending on the type of business and the length and severity of the outage.

Rock solid reliability starts with the CPU at the silicon level. The Intel® Xeon® processor E7 family RAS capabilities help enterprises attain 99.999% uptime or better. It utilizes continuous self-monitoring and self-healing capabilities to detect, contain, correct and recover from errors to avert system failure. The Intel Xeon Processor E7 family targets large enterprises running data intensive and mission-critical applications such as Big Data Analytics, business intelligence, large databases and heavy transactional processing in virtualized and cloud environments.

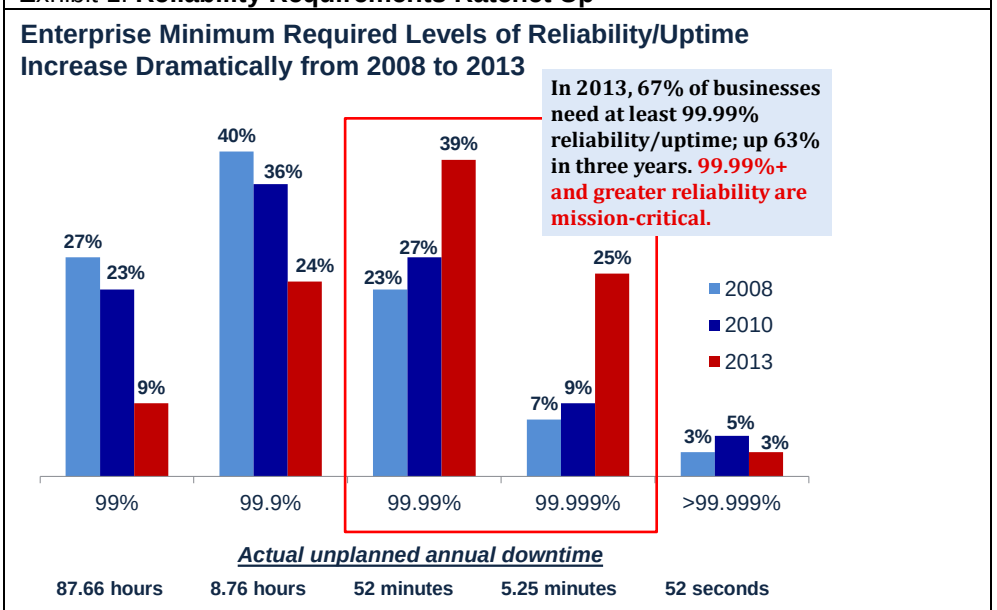
The Intel Xeon processor E7 family is closing the reliability, availability and serviceability gap with traditional competing RISC (Power and SPARC)-based processors. The Intel Xeon processor E7 family provides enterprises with an alternative, highly reliable x86-based system that may cost on average 20% to 50% less than comparable proprietary solutions depending on configuration, individual OEM vendor pricing, the applications deployed and the corporation's specific volume discounts. The Intel Xeon processor E7 family delivers x86 volume-based economics which can save enterprise organizations and their IT departments substantial amounts of upfront capital costs in server hardware and lower TCO over the entire product lifecycle.

Introduction

To reiterate, ***any*** downtime is an anathema to business operations. Enterprises depend on their compute infrastructure to conduct business 24/7. Overall system reliability is further taxed by the increasing numbers of remote and mobile users. ITIC survey data indicates that 77% of business employees now access the corporate data from home, while traveling and using their own devices (BYOD) during off-peak hours at least several times per week. System downtime quickly disrupts operations and end-user productivity and adversely impact business partners, suppliers and customers. Even when the system goes down, it is critical to bring it back up as quickly as possible — within minutes if not within seconds — to meet the customer service-level agreement (SLA). Robust hardware-based resiliency features are required to quickly identify the fault and if feasible self-heal the system to minimize or eliminate application and service disruption. Additionally, there is a heightened risk of noncompliance and litigation if the organization fails to meet SLAs due to noncompliance with regulatory issues like Sarbanes-Oxley (SOX) and the Health Insurance Portability and Accountability Act (HIPAA). Enterprises in vertical markets such as banking, finance, stock exchanges, insurance, healthcare and legal that routinely perform data-intensive transactions risk losing millions during outages of even a few minutes duration.

An examination of ITIC's independent Global Server Hardware and Server OS Reliability surveys over the last five years show that the percentage of corporations requiring 99.99% and 99.999% reliability and uptime has tripled. In ITIC's 2008 Reliability survey, two-thirds of organizations required just two or three "nines" of per server, per annum reliability. ITIC's latest 2013 Reliability Survey results indicate a complete reversal. In just three short years, the number of respondents requiring "four nines" or better reliability/uptime has increased by 63%. Today, over two thirds — or 67% of businesses say they need four, five or six "nines" of availability **(See Exhibit 1)**. This is the equivalent of 52 minutes; 5.25 minutes or 52 seconds of per server/per annum downtime, respectively.

Exhibit 1. **Reliability Requirements Ratchet Up**



Source: ITIC 2013

Overview: Intel Xeon Processor E7 Family RAS Capabilities

Fueling enterprises' reliability requirement for 99.99% or greater, is that the systems and server-based applications such as databases, Big Data Analytics, business intelligence (BI), customer relationship management (CRM) and enterprise resource planning (ERP) are all getting larger. Servers are now routinely equipped with a greater number of CPU cores and more robust memory configurations to accommodate more data-intensive workloads and higher memory capabilities. Demand-intensive workloads and applications consume large amounts of memory and CPU and take longer to restart and recover in the wake of an outage. The greater demands placed on systems make the Intel Xeon processor E7 family RAS features essential.

The Intel Xeon processor E7 family built on 32 nm Intel technology supports up to 10 cores and 20 hardware threads in either two, four or eight socket configurations, natively. Very large enterprises can scale beyond eight sockets by utilizing third party OEM node controllers. The eight sockets support a maximum 4 terabytes (TB) of memory and as many as 80 cores; this is double the maximum amount of memory customers could install on the prior Intel Xeon processor 7500 series. When fully populated using 32 gigabytes (GB) Dual In-Line Memory Modules (DIMMs), a 4-socket server configuration can support 2 TB of memory. This is the type of RAM capacity that enterprises require to support and power large in-memory databases and applications in physical, virtualized and cloud environments.

The key RAS features in the Intel Xeon processor E7 family center around continuous self-monitoring and self-healing functions that bolster system uptime and reliability including:

- Machine Check Architecture Recovery
- Memory Mirroring (Standard and Fine-Grained) and Memory Sparing
- Enhanced DRAM Double Device Data Correction (DDDC+1) & Enhanced DRAM Single Device Data Correction (SDDC+1)
- Corrected Machine Check Interrupt (CMCI) + Predictive Failure Analysis (PFA)
- Intel® QuickPath Interconnect (Intel® QPI) Self Healing)
- Intel® QPI Clock Fail-Over
- Intel® Scalable Memory Interface (Intel® SMI) Lane Failover

The Machine Check Architecture (MCA) Recovery feature, for example enables the CPU and operating system to isolate errors that could potentially crash the servers, such as uncorrectable memory errors resulting from alpha particle strikes or DIMM failures. Other features include Intel® Quick Path Interconnect (QPI) self-healing to protect against crashing due to persistent errors detected in interprocessor communication and Intel Scalable Memory Interconnect (SMI) Lane Failover to handle errors detected in a specific memory data lane.

Individually and collectively, the aforementioned RAS capabilities harden servers in a variety of ways that make a compelling business case for enterprises. The Intel Xeon processor E7 family builds on the capabilities and foundation of earlier Intel x86 processors and the Intel® Itanium® processor. The Intel Xeon processor E7 family provides enterprises that use Windows Server, Red Hat Enterprise Linux 6, SUSE Linux Enterprise 11 Service Pack 1, Oracle Solaris10 and Open Solaris high-end reliability capabilities in silicon.

Intel Xeon Processor E7 Family: Synergy with Server Hardware and Server OS

From the late 1980s through the late 1990s bugs and flaws in new versions of server hardware and new releases and even minor upgrades of server operating systems and applications were commonplace. So were incompatibilities amongst the system components, which led to overall system instability, which frequently meant server and OS crashes and applications freezing up.

These types of serious bugs and incompatibilities among the various components — from silicon to BIOS and chassis, to firmware, hardware and applications — which caused significant performance and reliability issues for months after nearly every new product release. This rarely happens these days. Bugs and incompatibilities still persist. But they are not nearly as pervasive and pernicious as they were a decade ago.

These days vendors (even rivals) take a more synergistic and collaborative approach when building products. This approach is a crucial component to building better systems and applications that deliver the high performance, reliability and manageability necessary to right-size workloads in physical, virtual and cloud environments.

The synergies among silicon, drivers, APIs, firmware, hardware, operating systems and applications enable each component to achieve greater economies of scale, while also hardening the systems to extend the useful product life.

OEM hardware and server operating system vendors have matched Intel's RAS initiatives via collaborative joint engineering efforts. Intel has for example, a host of strong relationships and alliances with many vendors, including but not limited to, IBM, HP, Microsoft, Red Hat and SUSE to support joint engineering and promote technical synergies and feature integration.

To cite just one example, the results-oriented collaboration between Intel and Red Hat aligns their respective technology roadmaps, collaborative contributions to the open source community, and develops Red Hat Enterprise Linux for optimal results on Intel architecture-based systems.

Red Hat Enterprise Linux 6 scales easily to support the largest Intel Xeon processor-based servers available today and much larger servers to come. The OS can take advantage of cores and parallelism using advances such as multiqueue networking, asynchronous I/O, and SR-IOV.

Combined with Intel's technology roadmap, these advances ensure enterprises can scale solutions to handle more users, heavier workloads, and larger data sets as needs evolve. Intel and Red Hat worked together to deliver synchronized hardware and software support for nonuniform memory access (NUMA) technology. NUMA allows memory allocation to be optimized across large numbers of processing cores. It enables each core to make optimal use of fast, nearby memory to minimize latencies, while supporting efficient memory sharing among all cores.

Prior to this, users in these open architecture environments relied on a variety of approaches to improve system uptime — most of which involved reconfiguring servers. This includes configuring multicore x86 servers to provide high availability clusters; fault tolerant x86 servers with complete built-in redundancy and or a hybrid server infrastructure with dynamic resource allocation. While these technologies did increase system reliability and availability, they were/are expensive and difficult to install, configure and manage.

Intel Xeon Processor E7 Family Consolidation, Scalability Benefits

The Intel Xeon processor E7 family RAS features solidifies and extends Intel's commitment to support the large base of open architecture enterprise customers with the same high level of reliability, availability and serviceability available in proprietary RISC/Unix -based systems at more affordable x86 price points. Businesses can deploy Intel Xeon processor E7 family-based servers to consolidate their server farms in virtualized environments or in a cloud computing infrastructure. In these high-level workload scenarios, a single server equipped with the Intel Xeon processor E7 family can host multiple virtual machines (VMs) with much greater capacity. For example, one VM can span multiple processors and require very large amounts of memory or multiple large VMs with peak workload requirements that may require 10 times the amount of normal processing. This type of scenario requires a very scalable platform which the Intel Xeon processor E7 family provides.

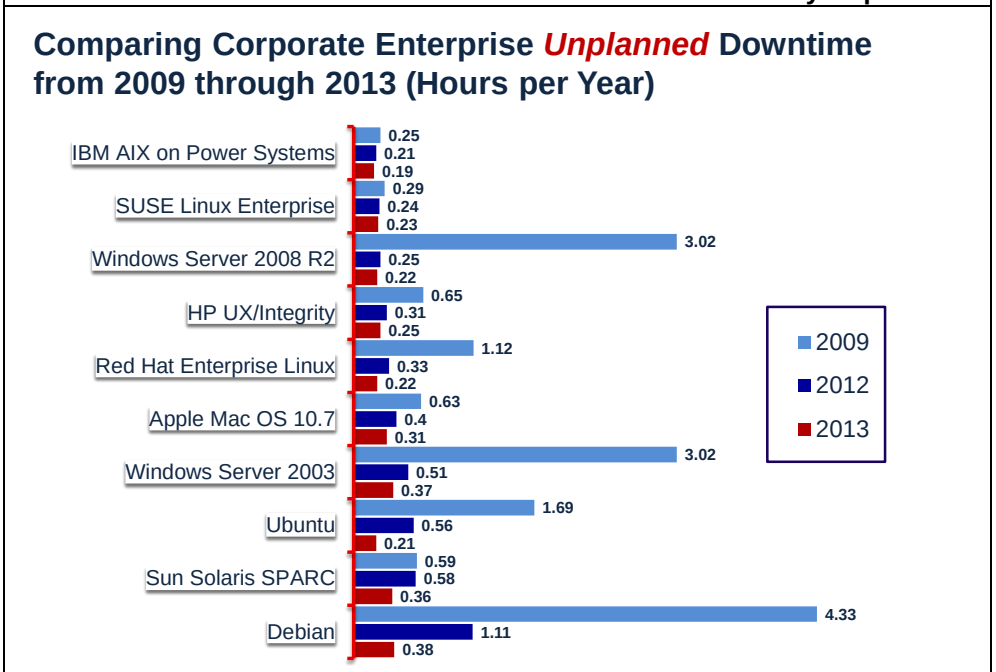
Enterprises must also have confidence that a data error in a single VM would not cause a failure affecting all of the VMs on the server resulting in a protracted and expensive outage. Virtualization and cloud computing are now mainstream technologies and increasingly comprise a greater percentage of the network infrastructure.

To reiterate, Intel works closely with Linux server OS providers Red Hat and SUSE as well as Microsoft to deliver the same tight integration between the silicon and the operating system as rival IBM has done with its Power processors and its AIX operating system. The economies of scale available with the Intel Xeon processor E7 family are passed onto OEM hardware vendors, which are then passed along to end customers. Organizations can expect to pay approximately 20% to 50% less than comparably configured RISC servers.

Data & Analysis

Intel Xeon processor E7 family-based servers are available from a wide variety of third party OEM hardware vendors running Microsoft Windows Server, Red Hat Enterprise Linux (RHEL) and SUSE Linux Enterprise and now provide the same high levels of reliability and availability as their Power and SPARC counterparts **(See Exhibit 2 and Exhibit 3)**.

Exhibit 2. **x86 Xeon Processor E7 Servers Close RISC Reliability Gap**

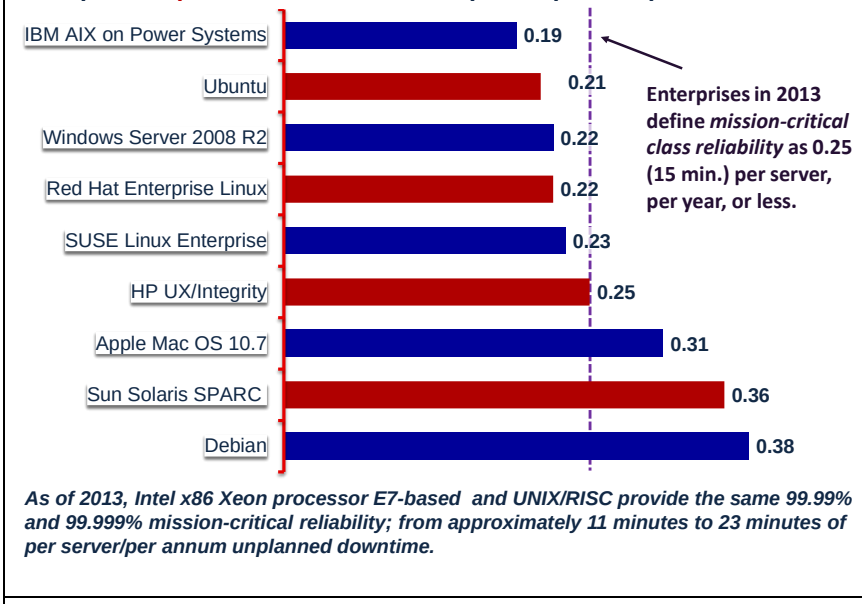


Source: ITIC 2013

Since 2008 when ITIC began polling enterprises on server hardware and server OS reliability, the x86-based platforms have steadily closed the gap on their RISC/UNIX counterparts. The ***inherent*** reliability of the UNIX/RISC and x86-based servers running Windows, Linux, UNIX and Open Source is now very close. As **Exhibit 3** below illustrates, in 2013, Intel Xeon processor E7 family-based and UNIX/RISC systems provide near equivalent 99.99% and 99.999% levels of reliability/uptime which is generally considered the target for mission-critical availability. The survey responses showed reliability levels on all platforms that ranged from approximately 11 minutes to 23 minutes of per server/per annum unplanned downtime. Among those enterprises that noted a greater disparity in the uptime and availability of x86-based Intel Xeon processor E7 family systems, the survey responses indicated that the main culprit was the way in which users deployed the systems. For example, nearly 60% of x86-based users reported retaining their servers for four, five or even six years without upgrading or retrofitting the hardware systems to accommodate greater workloads and more memory intensive applications.

By contrast, a higher percentage of enterprises that deploy RISC/UNIX systems — 44% — upgrade or right-size their servers regularly every three-to-four years.

Exhibit 3. **x86 Xeon Processor E7 Servers Close RISC Reliability Gap**



Source: ITIC 2013

Reliability Trends 2008 to 2013

ITIC's annual Global Server Hardware and Server OS Reliability survey polls corporations on the reliability and availability of the 14 major server hardware and 18 server operating system distributions. The ITIC Reliability surveys also track the technology trends and business issues that positively and negatively impact system reliability and availability. The Top Five Reliability trends according to ITIC's 2013 poll are:

- **Some 67% of enterprises now require a minimum of 99.99% reliability or greater.** Between 2008 and 2013, requirements for 99.9% & 99.99% uptime reversed. In 2008, 40% of businesses required only 99.9% uptime whereas in 2013 four out of 10 firms now need a minimum 99.99% reliability and availability for their mission-critical systems.
- **Technology advances drive reliability gains.** The ***inherent*** reliability and uptime of nearly all of the 14 major server hardware and 18 server operating system distributions continues to improve. These tangible reliability improvements are due largely to the technical advances in the server hardware, server operating system and the underlying processor technology of the Intel Xeon processor E7 family which is optimized for high reliability and availability. Enhancements in memory and disk technology also fortify server reliability. The continuous silicon-based error detection, error correction and self-

healing capabilities in the x86-based Intel Xeon processor E7 family work in concert with server hardware and server OS technology advances, producing a more hardened system with improved reliability, availability, performance, scalability and security. Servers can support mission-critical applications, data intensive transactions and heavier workloads with fewer system failures and planned maintenance.

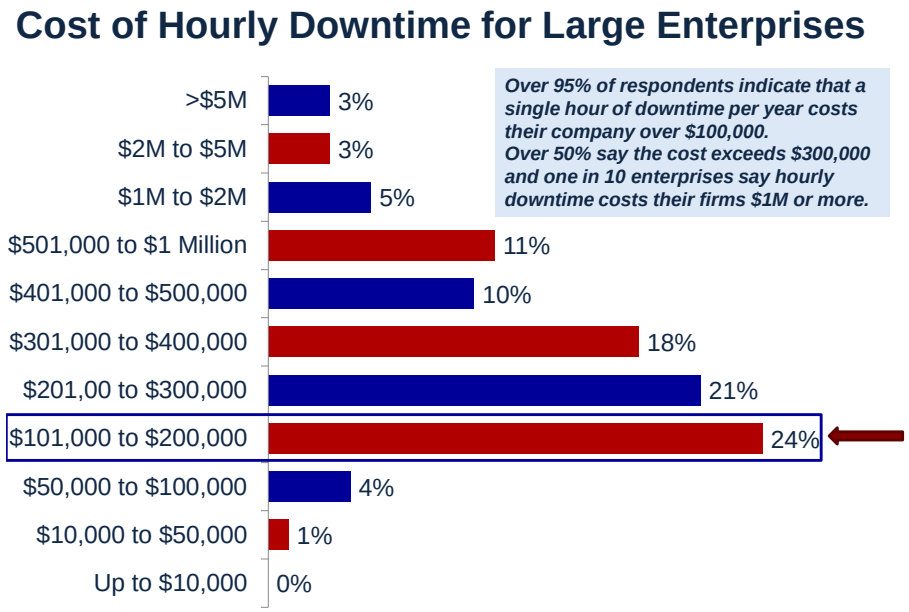
- **Corporate downtime on Intel x86, Intel Xeon processor-based systems has declined significantly in the last five years, closes in on RISC systems.** In the 2008 to 2009 timeframe, x86 servers from running Microsoft Windows, Novell/SUSE, Red Hat Enterprise Linux and other open-source server OS distributions experienced from one hour of unplanned per server/per annum downtime to as much as five and a half hours compared to just 15 minutes per server annually for an IBM RISC based Power System. But the latest ITIC 2013 Reliability Survey indicates that x86-based Intel Xeon processor E7 family-based servers from Dell, HP and others have reached near-reliability parity with RISC-based Power Systems servers and they have surpassed Oracle SPARC-based systems. The IBM RISC based Power systems recorded approximately 12 to 13 minutes of per server downtime compared to 14 to 16 minutes of per server downtime for the Intel Xeon processor E7 family-based systems; this is a variance of just two-to-three minutes.
- **Intel Xeon processor E7 family-based systems' reliability surpasses SPARC systems.** Oracle Solaris SPARC-based systems experienced an average of 22 minutes of unplanned per server downtime compared to 14 to 16 minutes for the various x86 Intel Xeon processor E7 family-based processors. The difference of seven to eight minutes less per server downtime does not initially appear great until one factors the number of servers in large enterprises. An organization with 100 Intel Xeon processor E7 family-based systems could experience a total of up to 800 minutes of annual downtime. By contrast, an enterprise with 100 Oracle Solaris SPARC systems could typically experience 2.7x more downtime in a year than the x86-based Intel Xeon processor-based systems — as much as 2,200 minutes of downtime.
- **Nearly half — 47% — of corporations say aging, inadequate hardware adversely impacts reliability and availability.** The 35% of respondents in ITIC's 2013 reliability survey who said aging servers 3½ years old or older didn't adversely impact reliability is down significantly from the 56% of participants who responded "No" in the ITIC 2011-2012 survey. The "Yes" responses nearly tripled to 17% from 6% in the prior 2011-2012 poll. A higher percentage of users in x86-based environments — 58% — acknowledged keeping their servers for four, five or even six years without retrofitting or upgrading key components like memory and hard drives to support mission-critical applications and data intensive workloads. The percentage was much lower — 29% — among corporations with a heavy concentration of RISC-based servers. Reliability and system uptime is equivalent among RISC and x86 Intel Xeon processor E7 family users that are on a three-year refresh cycle and companies that "right-sized" their servers to accommodate mission-critical workloads.

Downtime Gets More Costly

There is well documented evidence from a variety of sources indicating the rising cost of downtime. Hourly losses of $50,000, $100,000 or even millions due mainly to lost productivity and lost business revenue are common. Consider the following:

- A Gartner Group 2004 study found that the cost of downtime averaged $42,000 an hour.
- An Aberdeen Group 2012 cost of downtime study estimated that one hour of downtime cost averages from $98,000 to $138,000.
- A USA Today survey of 200 data-center managers found over 80% of respondents had downtime costs that topped $50,000 an hour and 25% said one hour of downtime cost their firms over $500,000.
- ITIC's May 2013 Technology Trends and Deployment Survey polled 600 businesses worldwide. It found 63% of large enterprises with 1,000 or more workers reported that one hour of downtime costs their business from $101,000 to $400,000 per hour exclusive of any litigation or compliance penalties **(See Exhibit 4)**. Only five percent of the large enterprise respondents said that an hour of downtime cost less than $100,000!

Exhibit 4. **Hourly Downtime Cost >$100K for Nine out of 10 Enterprises**



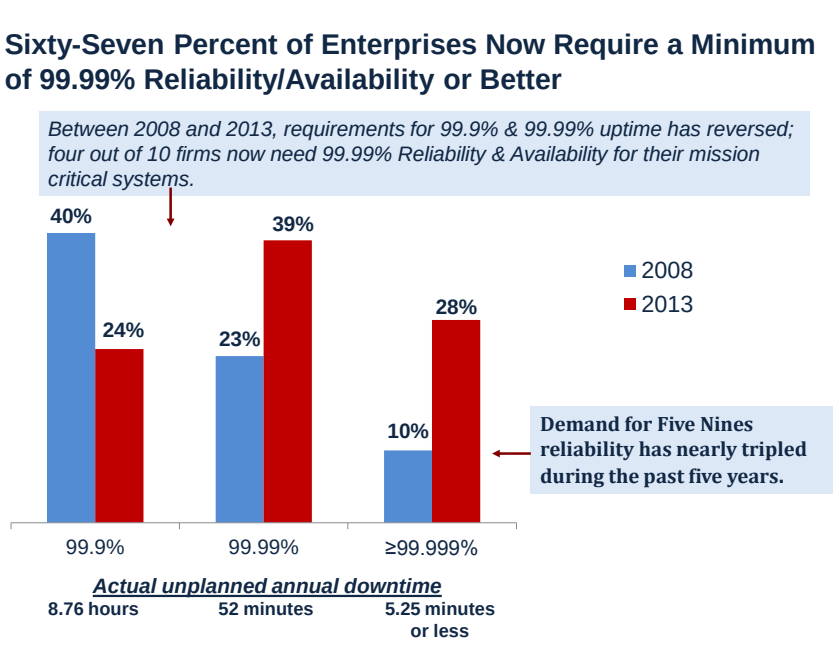
Source: ITIC 2013

The Intel Xeon Processor E7 Family RAS Improves TCA, TCO

All of the Intel Xeon processor E7 family RAS enhancements correspond to specific and tangible business benefits and to corporations' bottom line. The Intel Xeon processor E7 family RAS capabilities address enterprises' most pressing business needs for lower total cost of acquisition (TCA) and TCO; reduced ongoing operational and maintenance costs over the entire server hardware, server OS and application lifecycles and faster return on investment (ROI).

The Intel Xeon processor E7 family RAS' continuous proactive and preventative, soft and hard error detection, error correction and self-healing capabilities eases and speeds the provisioning and deployment of new servers, applications and services. Depending on the individual network workloads and configurations, enterprises can anticipate a reduction of 20% to 30% or more in administration tasks and time. The Intel Xeon processor E7 family's proactive, preventive and self-healing functionality and serviceability features such as CPU board hot swap and memory board hot swap, shortens even planned, routine service maintenance. Enterprises' need for servers that deliver data integrity, workload provisioning and very high system availability of 99.99%, 99.999% has tripled in the past five years **(See Exhibit 3)**.

Exhibit 5. **Percentage of Businesses Requiring 99.99% or Higher Reliability/Availability Quadruples Since 2008**



Source: ITIC 2013

These statistics beg the question: what happens to the enterprise infrastructure and its business if it lacks adequate RAS? Plenty — and predictably, none of it is good.

Servers, applications and services that lack the necessary reliability, availability and serviceability to discover and recover from soft and hard errors are more prone a variety of failures such as memory errors.

A Google, Inc. 2009 study titled "DRAM Errors in the Wild: A Large Scale Field Study" found that more than eight percent of Dual In-Line Memory Modules (DIMMS) and one-third of the machines in the study were negatively impacted by correctable (DCE) errors. The Google study noted, "Failures are costly both in terms of hardware replacement costs and service disruption."

The most tangible and net positive impact of the Intel Xeon processor E7 family RAS features and functions is a reduction in both unplanned outages and planned downtime for routine maintenance.

ITIC's Reliability survey research found that servers without RAS capabilities will decrease mean time between failures (MTBF), resulting in more frequent failures and more prolonged recovery time or mean time to recover (MTR), in the wake of a disruption or outage. ITIC research showed that organizations whose servers don't have RAS capabilities or perform automated updates to avoid rebooting the entire system, typically spend from 25 minutes to 72 minutes per month applying patches and updates as part of regularly scheduled planned maintenance. For servers with advanced RAS capabilities the annual time savings associated with planned maintenance is even more impressive. IT departments whose servers are without RAS-capable CPUs will spend from five hours to 14.4 hours per server or server farm (depending on whether IT departments apply upgrades manually to individual servers or use automated group policy) performing routine planned maintenance tasks. By contrast, IT departments using servers equipped with Intel Xeon processor E7 families will spend 1.4 hours to five hours annually on planned maintenance.

This in turn, has a net positive effect on the corporation's ongoing operational costs and activities.

Equally important is that the Intel Xeon processor E7 family's inherent RAS capabilities mitigate the risk of failure to an acceptable level and provide enterprises with a very high degree of assurance that will be able to meet their SLAs. This is crucial since today's enterprises are notoriously risk-averse. Regulatory compliance is becoming more stringent across many vertical market segments like banking and finance, defense, government, healthcare, legal and travel, to name a few. The monetary penalties for noncompliance violations are rising as well.

In January 2013, for example, the Department of Health and Human Services released its final HIPAA Omnibus Ruling substantially increasing the civil monetary penalties associated with a HIPAA privacy or security breach. A single instance of HIPAA noncompliance can cost the offending hospital or healthcare organization as much as $50,000 in fines; and healthcare firms could incur up to $1.5 million in a 12 month period for repeated violations.

The United States General Services Administration (GSA) likewise now provides stiff civil and criminal penalties for its employees, contractors and clients who violate the GSA Rules of Behavior in handling Personal Identifiable Information (PII) on security and data breaches.

In addition, corporate enterprises that are noncompliant also risk incalculable damage to their reputations, which in turn, potentially results in lost business and revenue.

Predictable Reliability

There is rarely, if ever an opportune time for a system or service failure. Another net positive effect of the Intel Xeon processor E7 family RAS capabilities is that the continuous error detection, correction, and self-healing features, provide enterprises with better reliability via predictive failure analysis capabilities that can alert IT managers of issues and avert downtime. An outage or service disruption that occurs during peak usage hours can quickly escalate with disastrous consequences across all business sectors. Consider these scenarios:

- **Healthcare:** A system failure during an operation could jeopardize human lives.
- **Banking and finance:** Unplanned outages during peak transaction time periods could cause business to grind to a halt. Banks might be unable to process deposits and withdrawal transactions and customers might not be able to access funds in ATM machines. Brokerage firms and stock exchanges routinely process millions and even billions of transactions daily, could conceivably lose millions if transactions or trading were interrupted for even several minutes during normal business hours.
- **Government agencies:** A system failure within the Social Security Administration (SSA) that occurs when the agency is processing checks could result in delayed payments, lost productivity and require administrators to spend hours in remedial action.
- **Retail:** Retailers and sales force personnel trying to close end-of-quarter results, would be hard pressed to do so if an outage caused them to be unable to access and log sales. This could have a domino effect on suppliers, customers and shareholders.
- **Travel and transportation:** An outage at the Federal Aviation Administration's (FAA) air traffic control systems could cause chaos: air traffic controllers would find it difficult to track flights and flight paths, raising the risk of massive delays and in a worst case scenario, collisions. An airlines reservation system outage would leave the airlines unable to process reservations and issue tickets and boarding passes via online systems.

Aside from the immediate consequence of being unable to conduct business and loss of revenue, unreliable systems undermine quality of service, potentially causing firms to be unable to meet SLA agreements. This can lead to breach of contract, cause the company to lose business and customers, and put it at risk for expensive litigation. The Intel Xeon processor E7 family RAS capabilities make reliability more predictable and help corporations to identify issues before they can compromise performance and data integrity. This singular predictability feature can reduce both the number of outages and cut down on planned maintenance downtime by 20% to 40%, according to ITIC's Reliability survey data.

Intel Xeon Processor E7 Family vs. RISC

The Intel Xeon processor E7 family RAS features have changed the dynamics of server reliability. They deliver mission-critical reliability in physical, virtual and cloud computing environments equivalent to RISC-based servers, when properly configured and deployed.

The Intel Xeon processor E7 family also affords large enterprises with several business advantages over competing RISC-based solutions. These include:

- **Choice:** Having the Intel Xeon processor E7 family as an option for mission-critical servers and data intensive workloads fosters competition amongst all platforms, providing users with a wider array of choices at more competitive price points. According to statistics presented in two (2) separate International Data Corp. (IDC) reports,[1] 85% of higher-end workloads — including BI, large databases, CRM and ERP applications, now run on industry standard servers because they offer comparable reliability, functionality and greater manageability.
- **Open architecture platform:** The Intel Xeon processor E7 family offers support for and provides integration and interoperability with a variety of standards-based open architecture platforms. This in turn keeps acquisition costs low, eases maintenance and administration and speeds deployment and provisioning compared with proprietary, closed systems architectures.
- **Wide range of available applications:** The Intel Xeon processor E7 family supports open architecture platforms like Linux, Open Solaris and Windows. This is a net positive for developers who can use standard APIs to build applications and accelerate development.
- **Lower TCA and TCO:** The inclusion of the Intel Xeon processor E7 family in many of the industry's most popular OEM servers provides enterprises with up-front capital expenditure price points that are on average 20% to 50% less expensive than comparable RISC machines (depending on individual configuration, the applications utilized and user-specific volume discounts). This also lowers TCO costs over the entire lifecycle, although the specific savings will vary according to the corporation's use model.
- **Widespread availability of IT administrators:** There is better availability of skilled x86-based administrators who are certified to manage and oversee open architecture environments compared to the RISC/UNIX environments.
- **Services from x86 OEM hardware and software vendor partners:** Intel is working closely with OEM and OSV/ISV companies to provide development, configuration and test guidance along with documentation and technical service and support.

[1] IDC's Server Workloads 2008, June 2008; IDC Special Study Server Workloads Forecast and Analysis Study, 2008 – 2013 (IDC# 219746)

Users Weigh In on Intel Xeon Processor E7 Family RAS

The Intel Xeon processor E7 family-based systems with their RAS capabilities has enterprises flocking to switch from more expensive, closed proprietary systems or add them to their the virtualization and cloud environments. Customers expressed confidence in all aspects of the Intel Xeon processor E7 family performance, reliability, scalability and manageability.

- **The Vontobel Group, an investment banking firm in Zurich, Switzerland:** The bank migrated from a RISC platform to the Intel Xeon processor E7-4800 product family and Intel Xeon processor 5600 series and achieved a three-fold boost of its core batch job processing and response to user queries. It also realized a 25% to 40% reduction in the cost of the upgrade compared to what it would have spent for a similarly equipped RISC processor system. The Vontobel Group reported 100% uptime during the first six months of operation.
- **Yunnan Telecom in Southwest China:** The largest basic network operator in the Yunnan Province sought to improve performance and implement a cost-effective, rapid and efficient billing system. Like Vontobel Group, the Chinese telecom provider needed a trouble-free migration from its RISC based servers. It also required 24/7 uptime for its mission-critical B/OSS billing system. Following a successful test and deployment, Yunnan Telecom's analysis of the Intel Xeon processor E7-4870-based servers found that it took over up to 40% of the high end RISC-based server workloads, while CPU and memory usage remained low. Overall, Yunnan Telecom reported a 3x to 5x improvement in cost effectiveness; it cut TCO by almost 60% compared to the legacy RISC platform and delivered near-flawless 99.999%.

C-level executives, IT managers and consultants interviewed by ITIC also voiced their enthusiasm and support for the Intel Xeon processor E7 family RAS capabilities.

A vice president of network architecture at a large Midwestern bank with over 20,000 employees said his organization has pilot-tested the Intel Xeon processor E7 family in both Dell PowerEdge and HP ProLiant servers to support databases in its customer service center. He indicated the bank plans to roll them out in new virtualization networks within the next six months. "We're satisfied that the Xeon Processor E7 meets our two biggest requirements: extremely high reliability that's equal to our RISC-based systems but at 40% to 50% less cost," the VP of IT architecture said. "As a bank we have no tolerance for risk or downtime. We're confident the Xeon Processor E7 can deliver five nines of reliability or better," he said. The VP added the bank is especially impressed with the Intel Xeon processor E7 family's preventative self-healing capabilities, such as the QPI dynamic width reduction, which he estimates will cut planned downtime by up to 50%.

Andrew Baker, president of Brainwave Consulting in Charleston, West Virginia and a former VP of IT at several large enterprises like Bear Stearns and Time Warner Music concurs.

"Intel's Xeon Processor E7 has reached parity with RISC and SPARC. I don't see any material functional advantage today of the RISC and SPARC-based hardware platforms vs. Intel's and E7," Baker says.

According to Baker, the Intel Xeon processor E7 family RAS features are especially pivotal in two key areas. They are: enterprise databases and very concentrated virtualization environments with several VMs hosting 30, 40 or more virtual systems, where the organization has no tolerance for downtime or system errors.

From a business perspective, Baker believes the Intel Xeon processor E7 family fills a need for organizations looking to migrate from more expensive RISC systems, who want very high reliability and ease of use and deployment.

Organizations like scientific and engineering firms and stock exchanges find the Intel Xeon processor E7 family appealing because of its in-memory capability, core density and state-of-the-art encryption. As core density gets greater with virtualization, enterprises are more concerned about CPU reliability and data integrity, Baker says. “These features are awesome. I can translate them to something that overcomes my business clients’ specific challenges like virtualization.”

Baker says enterprises will easily grasp that in a server farm of 20 systems, at some point hardware errors will manifest and those errors need to be curtailed and contained so they don’t disrupt business operations. The Intel Xeon processor E7 family’s ability to accomplish that is “a big selling point.”

“I can use the extra benefit of the CPU RAS to mitigate the cost of a high end ECC (error-checking) RAM,” Baker says. The Intel Xeon processor E7 family’s predictive failure analysis also resonates. “If they [Intel] gave them to me even with a $100 price premium or even if it doubled the price of the processor for a low core count E7, I would use it for my database servers, my virtualization systems and wherever business logic and business intelligence was taking place. It’s that necessary to overall system reliability and health,” Baker says.

The competitive pricing for Intel Xeon processor E7 family-based server hardware also makes a compelling business case for the Intel CPUs in a wide range of OEM systems. “There could be 30% to 40% price differential. Intel is pricing the Xeon Processor E7 line to appeal to businesses that want to shift from IBM’s Power 6 or Oracle’s Solaris. Everyone wants to save money,” Baker says.

Conclusions

The Intel Xeon processor E7 family brings high end RAS capabilities to open architecture x86-based servers and operating systems like Windows, Linux, Solaris and Open Solaris. It provides a reliability alternative to RISC (Power and SPARC)-based servers at an economical price point that is 20% to 50% less expensive than rival RISC -based systems depending on specific user configurations and volume discounts.

To aggregate the findings:

- A 67% majority of organizations now require a minimum of 99.99% or 99.999% uptime.
- The cost of hourly downtime continues to increase. ITIC survey data shows that six out of 10 businesses found that one hour of downtime costs between $101,000 and $400,000.
- Regulatory compliance measures are becoming more stringent. And the penalties associated with noncompliance are also increasing.
- Lack of system reliability and availability raises companies' risk of expensive, protracted litigation; damages the business' reputation and results in potential lost business.
- Larger, more data intensive applications like Big Data Analytics, CRM and ERP place greater demands on system resources.
- The Intel Xeon processor E7 family offers equivalent 99.99%, 99.999% and higher mission-critical reliability as proprietary RISC/UNIX processors.

No vendor can guarantee that any processor, hardware device, software application or service will have zero risk of failure. But the enhanced RAS capabilities of the Intel Xeon processor E7 family significantly lowers the probability of downtime, reduces the frequency and the duration of outages when they do occur and assists companies in mitigating risk to an acceptable level.

Enterprises must have rock solid hardware to achieve these optimum levels of uptime. The silicon-based RAS enhancements in the Intel Xeon processor E7 family provide the error detection, correction and containment in all memory, processors and I/O data paths necessary to achieve four, five and even six nines of availability. The technology advances and business advantages of the Intel Xeon processer E7 family make a clear and compelling case for enterprises to switch to open architectures from proprietary RISC systems.

Appendix 1: Methodology

Intel Corp. commissioned ITIC to write a Report that details and analyzes the reliability, availability and serviceability (RAS) features and capabilities of the Intel Xeon processor E7 family. The intent of this Report is to illustrate the requirements and tangible business benefits for the highest levels of reliability and availability for mission-critical hardware, applications and services. This Report also details the net positive impact the Intel Xeon processor E7 family on daily business operations. It elucidates the very high availability, proactive, preventative maintenance, error detection, error correction and self-healing capabilities needed for virtualized and cloud computing environments at an affordable price point. And it compares the benefits and downtime statistics relative to comparable competing proprietary hardware offerings from IBM and Oracle (formerly Sun Microsystems).

ITIC utilized the findings from **ITIC's 2008, 2010 and 2013 Global Server Hardware and Server OS Reliability Surveys and the ITIC 2013 – 2014 Technology and Cost of Downtime Trends** survey to track reliability requirements and cost of downtime trends over the past five years**.** The latest 2013 Reliability survey polled C-level executives and IT managers at over 550 corporations worldwide from August 2012 through February 2013. In order to ensure objectivity, ITIC accepted no vendor sponsorship and none of the participants received any remuneration. ITIC also gathered data on Reliability and cost of downtime statistics obtained from publicly available sources. Additionally, ITIC conducted first person customer interviews to obtain anecdotal data on specific user requirements and to query corporations on their opinion of the Intel Xeon processor E7 family. The interviews provide deeper insight into the business and technology challenges confronting corporations.

Appendix 2: Reliability/Uptime by the Numbers

TABLE 1: Reliability/Uptime by the Numbers

Availability %	Downtime per year	Downtime per month*	Downtime per week
90% (one nine)	36.5 days	72 hours	16.8 hours
95%	18.25 days	36 hours	8.4 hours
97%	10.96 days	21.6 hours	5.04 hours
98%	7.30 days	14.4 hours	3.36 hours
99% (two nines)	3.65 days	7.20 hours	1.68 hours
99.5%	1.83 days	3.60 hours	50.4 minutes
99.8%	17.52 hours	86.23 minutes	20.16 minutes
99.9% (three nines)	8.76 hours	43.8 minutes	10.1 minutes
99.95%	4.38 hours	21.56 minutes	5.04 minutes
99.99% (four nines)	52.56 minutes	4.32 minutes	1.01 minutes
99.999% (five nines)	5.26 minutes	25.9 seconds	6.05 seconds
99.9999% (six nines)	31.5 seconds	2.59 seconds	0.605 seconds
99.99999% (seven nines)	3.15 seconds	0.259 seconds	0.0605 seconds

Appendix 3: Links and Further Reading

The following is a list of pertinent links to suggested reading on the Intel Xeon processor E7 family specifications, pricing and technical articles and White Papers from Intel.

Intel Xeon Processor E7-8800/4800/2800 Product Families Specification Update – January 2013 http://www.intel.com/content/dam/www/public/us/en/documents/specification-updates/xeon-e7-8800-4800-2800-families-specification-update.pdf

Intel Xeon Processor E7 Family: Reliability, Availability and Serviceability
http://www.intel.com/content/dam/www/public/us/en/documents/white-papers/xeon-e7-family-ras-server-paper.pdf

Intel Server Upgrade Savings Estimator Tool:
http://www.intel.com/content/www/us/en/education/it-in-education/server-upgrade-savings-estimator-landing.html

Google Research, "DRAM Errors in the Wild: A Large-Scale Field Study,
http://research.google.com/pubs/pub35162.html

April 13, 2013 article on Datacenter Knowledge:
http://www.datacenterknowledge.com/archives/2013/04/02/the-role-of-the-cloud-in-rto-and-rpo-planning/

Intel Technology Journal article on "autonomic foundation for fault diagnosis, Vol 16, Issue 2, 2012:
http://noggin.intel.com/content/autonomic-foundation-for-fault-diagnosis

Intel Xeon processor E7 Family Pricing
http://ark.intel.com/products/family/59139/Intel-Xeon-Processor-E7-Family/server