White Paper

IBM zEnterprise
Opens New Horizons for SAP Customers

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Executive Summary

In July 2010 IBM announced the IBM zEnterprise System opening new horizons for SAP customers. zEnterprise is a workload optimized system which enables a mixed set of workloads to be deployed on best fit technologies to meet the business needs of today's multi-tier SAP landscapes. This hybrid infrastructure provides the broadest systems architecture for SAP by combining the industry's most robust data serving and high availability with IBM's POWER7 and System x blades, and enabling them to be managed end-to-end as a single, virtualized system.

A private high speed internal connection between the zEnterprise (z196) and IBM blades ensures better performance and throughput with the highest levels of security for mixed SAP workloads. The *zEnterprise Unified Resource Manager* provides a single point of control to manage the SAP multi-system landscape. System z is an ideal database platform for DB2 on z/OS, while application servers can run on AIX on POWER 7 or on Linux or Windows on x86 blades inside a zEnterprise *BladeCenter Extension (zBX)*. Other SAP technology components such as web-access tier applications and third-party products, which are not supported on z196, can be deployed on zBX blades.

When managing a complex SAP multi-platform infrastructure, data availability, adequate service delivery, and security are the top challenges for IT executives. For many organizations, SAP's *Enterprise Resource Planning (*ERP) software plays a crucial role in areas, ranging from human resources and sales management, to logistics. SAP on System z supports ERP financials, HR, CRM/SCM/SRM and certain industry-specific solutions such as core banking, Bank Analyzer (reporting), risk and compliance, insurance, retail and automotive applications.

SAP ERP applications are based on three-tier architecture: database server, application servers, and the presentation clients connected via the Internet or Intranet. Currently, there are about 1500 installations running SAP in production on System z. Initial deployments used the mainframe as a DB2 database server using AIX-based UNIX or Windows as the application server. The connection between the two platforms was via an external TCP/IP connection. So far, this has been the most popular deployment of SAP on System z;

however, a recent trend is to use the Integrated Facility for Linux (IFLs) Linux capability of a mainframe as the application server. Using Linux on System z provides the fastest possible connectivity between the database and application server which can be a critically important differentiator in many situations. Also, use of Linux on z can provide lower landed costs where a small Linux capacity is required. Linux on z with zVM combines the industry's gold standard of server virtualization with highest internal server and data communications performance and qualities of service.

zEnterprise systems opens new options for SAP ERP and other applications. zEnterprise can run AIX, Linux and Windows applications unchanged on zBX supported operating environments zBX supports logical device integration between z196 and distributed resources. *Unified Resource Manager* unifies resources and extends System z qualities of service across the infrastructure to install, monitor, manage, optimize, diagnose, and service. In addition to SAP, the system is an ideal platform for multi-tier web-serving which is typical to banking, insurance, government, and healthcare users, which require scalability and flexibility. Other examples are Business Intelligence / Data Warehousing applications which exploit the POWER7 processor's speed and DB2 for z/OS features. Applications running on zEnterprise benefit from mainframe qualities such as unmatched security, high availability, and powerful disaster recovery techniques with HyperSwap and GDPS.

> *"The hybrid zEnterprise delivers a true end-to-end infrastructure delivering highly available and secure SAP applications"*

zEnterprise is the most robust, the most secure and, the same time, the most versatile platform with the most advanced virtualization features supporting all System z operating systems, plus Java, Linux, AIX, and now Windows. The platform is highly automated, requiring little management, which translates to lower staff costs. The July 12th announcement introduced the entry-level zEnterprise 114 (z114) models with better software and hardware pricing, suitable for raised-floor and non-raised-floor data centers. The new model and the price reduction introduce affordable options for small organizations without mainframe experience to benefit from all the advantages of the zEnterprise. The hybrid zEnterprise delivers a true end-to-end secure infrastructure for SAP applications.

Conclusions Summary

SAP ERP on System z has always been a solid enterprise platform; but zEnterprise raises the bar by offering an integrated system for heterogeneous hardware, as well as software platforms that address the major infrastructure requirements of businesses looking for security, business continuity, and performance. Practically any SAP application can run on a single zEnterprise system. The various blade technologies offer flexibility in selecting options for web applications. The Unified Resource Manager acts as a central point of control–a centralized governance system that can manage an underlying z/OS, Linux on System z, AIX

on POWER, or Linux and Windows on System x under a single-management umbrella, thus simplifying system management at lower management costs.

SAP ERP on System z – options

There are several options to run SAP ERP on System z. Historically, the first one was a database server with DB2 on a mainframe while using TCP/IP with channel processing controllers or Open Systems Adapters (OSA) with AIX-based UNIX, Linux or Windows as the application server. Another application server option was to use the Integrated Facility for Linux (IFLs) capability of a mainframe as the application server. Application servers running on IFL can benefit from using internal HiperSockets[1] for improved performance.

zEnterprise has now introduced new option of hybrid platform with internal connectivity and common management.

System z as DB2 database server

Using DB2 on the mainframe allows for large database scalability, performance, I/O sharing, very high availability, and advanced disaster recovery techniques. An SAP ERP can span multiple servers in a Parallel Sysplex cluster with real parallel read/write data sharing capabilities. Mainframe internal hardware compression on all paths may save up to 70% of disk space and dramatically reduce data transfer times. In addition, part of DB2 execution can be offloaded to special zIIP engines, which are priced significantly lower than z/OS processors[2].
The major reasons to select System z as a database server for SAP applications are:

- High availability and manageability of large databases without the need for database splitting, which may result in losing a single view of the enterprise data.
- Automated Service Levels (SLAs) management by the Workload manager (WLM) in System z or Unified Resource Manager for zEnterprise models.
- DB2 on mainframe may use without any additional charge the hardware compression saving up to 70% of disk space and reduce dramatically data transfer times

[1]HiperSockets, unique to the System z series, provide lower-cost, fast, low-latency TCP/IP emulation within System z memory instead of TCP/IP communication via external devices. For example, this feature may reduce communication overhead and significantly increase performance of connecting DB2 running under z/OS with an application server in a Linux partition on IFL.
[2]The System z offload engines: System z Integrated Information Processor (zIIP) is used to offload DB2; System z Application Assist Processor (zAAP) supports Java code execution; Integrated Facility for Linux (IFL) runs Linux on the mainframe; Internal Coupling Facility (ICF) provides support for Parallel Sysplex clustering.
All of these offload engines are priced significantly lower than the usual z/OS engines. The computing power (MSUs) of these engines is excluded from software charges. Users who skilfully employ these engines can off-load their z/OS MIPS, stem z/OS growth requirements, and thus, lower TCO.

- Online database reorganization and DB2 release upgrade.
- Effective data sharing between systems in a Parallel Sysplex cluster.
- Ability of a single mainframe to handle multiple SAP database servers and databases.
- Synergy between SAP and DB2 on System z - IBM has implemented more than 100 feature requests over different DB2 for z/OS versions.

On March, 23, 2011 Oracle announced that it has discontinued all development efforts around Itanium, placing a question mark around Hewlett-Packard's high-end servers (HP-UX UNIX, OpenVMS, and Nonstop operating systems) running Oracle applications. This is another shot in the business and ego-driven war between Oracle and HP. The two companies have become heated rivals after Oracle's acquisition of Sun and its Sparc processor technology and Oracle's hiring of Mark Hurd, ex-CEO of HP. At the end of June, HP initiated legal actions to force Oracle to reverse this decision. Regardless of the outcome of this legal procedure, which may take years, Oracle may slow down enhancement developments for the Oracle database and other applications on Itanium.
Another reason to consider migrating to DB2 are the bitter relations between Oracle and SAP after the legal case in which Oracle won a $1.3 billion jury verdict against SAP. Taking this into consideration, it is unlikely that the cooperation between the two companies will continue as in the past. On the other hand, there are very good relations and a tight cooperation between IBM and SAP. IBM Global Technology Services (GTS) can perform migrations to DB2. With the DB2 Fastloader for SAP, databases can be usually migrated to DB2 within a day or weekend.
In conclusion, it seems that DB2 and, in particular, DB2 on System z is a safe harbor for HP/Oracle users.

The IBM zEnterprise Systems

IBM announced the zEnterprise series in July 2010 by introducing the z196 with ca. 40% more performance than its predecessor z10 and the zBX Model 002, which combines hybrid configurations of System z mainframes and POWER7 blades (zEnterprise BladeCenter Extension -zBX). The blades run AIX and use PowerVM as the virtualization hypervisor. PowerVM ensures high resource-utilization and ability to meet peak demands. The connection between the z196 and the zBX is via an internal private high-speed data network–traffic on user networks is not affected. This private network does not require encryption, which translates to higher performance due to no encryption overhead. Both z196 and zBX support optional water cooling and, by using optional overhead cabling. The zBX can reside on a non raised-floor data centers, but must be within 25 meters of the z196. The z196 and the zBX solutions introduce tighter integration between the database and the applications that need access to System z data, but run on a distributed platform (see Figure 1).

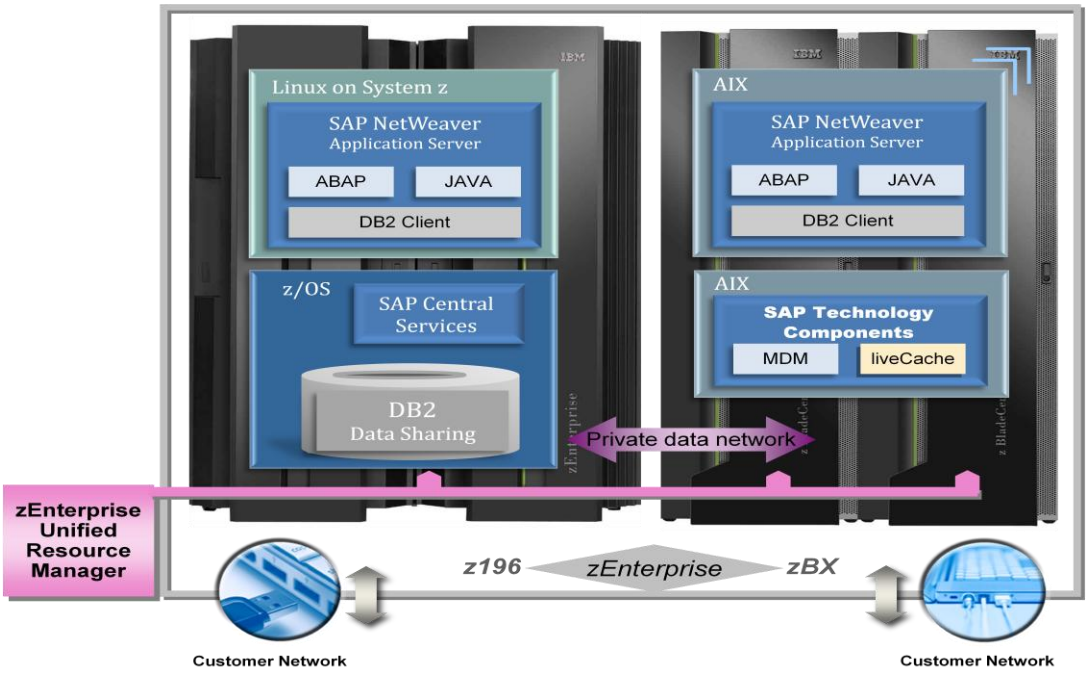

Figure 1: SAP on IBM zEnterprise System, Business Suite Reference Architecture. Source IBM.

The key component of zEnterprise is the *Unified Resource Manager* (URM), which provides advanced management of both platforms, System z and zBX, and–like System z *Workload Management* (WLM)–allows for automated resource management based on goals and policies defined as best for the business. The United Resource Manager manages the heterogeneous resources as one, dynamically assigning resources to meet user -specified service-level objectives. The central point of management for heterogeneous platforms reduces the need to manage individual resources and significantly reduces human-related tasks. The automated multi-tier management also allows for higher levels of utilization on all managed platforms.

"The key component is the Unified Resource Manager which provides advanced management of both platforms, System z and zBX […] "

On July 12, 2011 IBM announced the new entry-level z114 for midrange businesses, new I/O subsystem for improved system connectivity, and the introduction into zBX of System x blades running Linux and Windows. The improved range of the z114 models covers a range of 26 - 3100 MIPS, offering a granularity that should suit any organization. In addition to the mainframe side, IBM announced System x Blades (x86 platform) for the zBX. Unified Resource Manager will load the blades with a KVM-based hypervisor. The blades can run Linux or Windows operating systems.

Up to 112 Blades are supported on a single zBX supporting the ability to mix and match POWER7 and System x blades in the same system, creating a real hybrid multi-platform,

multi-operating-systems system. A zEnterprise node is a z196 with up to 1 zBX. Up to 8 zEnterprise nodes with up to 896 blades may be configured into a zEnterprise Ensemble. zEnterprise Unified Resource Manager can manage a zEnterprise Ensemble as a single logical virtualized system.

Business continuity of SAP on System z

One of the strongest arguments in favor of deploying SAP ERP on System z is the highest standard of hardware and software availability and advanced disaster recovery capabilities of this platform. High-availability systems are designed to have no single points of failure (SPOF) and no single points of repair (SPOR) through the use of redundant components and architectures. Non-disruptive upgrades and micro-code updates also play a crucial role in achieving high availability.

System z supports Parallel Sysplex as a local or remote cluster. Up to 32 local or remote mainframes can participate in a single cluster. System z Parallel Sysplex also works in conjunction with IBM's disaster recovery software called Geographically Dispersed Parallel Sysplex (GDPS). GDPS enables automated complete site fail-over with no or minimum loss of data. IBM's GDPS for System z is a multi-site application availability solution, with fast recovery time and highly-automated control. It manages application availability in and across sites for both planned maintenance and unplanned situations, such as a site failure or full-blown disaster.

In June 2011 IBM extended the zEnterprise business resiliency strength via significant enhancements to GDPS: an active/active configuration (in addition to the active/standby, which is commonly used). The GDPS active/active continuous availability is the next generation of GDPS and a fundamental shift from a failover model to a near-continuous availability model. IBM intends to deliver, over time, additional configurations that comprise GDPS active/active continuous availability - a solution for organizations using two sites separated by unlimited distances, running the same applications, and having the same data with cross-site workload monitoring, data replication, and balancing.

" The GDPS active/active continuous availability is the next generation of GDPS and a fundamental paradigm shift from a failover model to a near continuous availability model."

Another availability function is the *HyperSwap* function. This function is probably the most important business-continuity and availability improvement for IBM mainframes. While disasters rarely occur in reality, disk subsystem failures are far more likely to happen. In current integrated and complex application environments– assuming a highly-available data-sharing Parallel Sysplex environment–disk becomes a single point of failure for the entire Sysplex. The HyperSwap function, which is used by multiple GDPS solutions, is controlled by GDPS automation. Use of HyperSwap can eliminate an outage caused by planned maintenance or disk failure by

reducing the time needed to switch disks between sites to a matter of seconds and allowing the primary site to use the secondary site's disk storage subsystems.

Basic HyperSwap between two remote or locally-installed storage subsystems in order to provide automated fail-over for planned or un-planned outages can be deployed with z/OS alone, without requiring multi-site GDPS. Like with GDPS, there is no equivalent functionality on any other platform besides System z.

System z Security

System z has provided robust hardware and software solutions to answer cryptographic security needs for almost two decades. For more than a decade, IBM mainframes have been certified at the highest security level. The follow-on generations of cryptographic-coprocessor features have received similar certification for secure-key processing.
On March 2003 IBM's eServer zSeries 900 (z900) was the first server to be awarded EAL5 security certification (the highest commercial level). The subsequent mainframe generations were awarded the same level. The z196 has received EAL+5 security certification.

Total Cost of Ownership

Considering TCO in the life-time of the product is usually the weakest point in IT procurements. Most users compare the hardware and software purchase price only, some consider maintenance and energy costs as well, but almost nobody takes into consideration the financial damage that can be incurred as a result of planned or un-planned downtimes, for example. Which are the factors which in reality reflect the true TCO value?

- Purchasing price or leasing rates (determined by interest and residual value) for hardware and software
- Estimated upgrade costs over the lifetime of the equipment
- Hardware and software maintenance
- Energy costs (power and cooling)
- Floor space
- Personnel costs
- Professional services
- Financial damages caused by downtime.

Mainframe procurement costs are usually higher, but a detailed TCO calculation can prove that the TCO over the whole life cycle of a mainframe system is lower than that of other platforms. In other words, mainframes are not cheap, but they represent the best value for money in current IT.

IBM has responded to competitive workload pricing for SAP on the System z platform with the introduction of solution edition pricing for new workloads. The IBM System z Solution Edition for SAP allows existing and new customers to cost effectively deploy new SAP

workloads on the platform where prior pricing metrics made the economics cost-prohibitive for customers who desired the platform's advanced capabilities. When combined with specialty engine pricing for Linux and Java, three-tier SAP applications that need the scalability of System z, especially for multi-landscape deployments on SAP, can be competitively priced[3]. The IFL and the zIIP engines cost a fraction of z/OS engines. One customer in Denmark running SAP on System z manages to offload ca. 1700 MIPS to 5 zIIPs at peak times, resulting in substantial savings on hardware and software. z/VM pricing is value based pricing and is dependent on the number of engines.

Major TCO savings can be achieved through the reduction of processors and man-power. For example, Oracle software charges are based on the number of processors and one mainframe engine can replace several RISC or x86 processors. Of the several users I have interviewed, all emphasized the reduction in man-power requirements after consolidation from UNIX or Windows to mainframe. Additional savings can be achieved as the result of lower energy and floor space requirements. With skillful negotiations, SAP ERP on System z may cost 20-25% more than comparable deployments on UNIX; however, because of the large potential savings, the return on investment (ROI) can be reached in a relatively short time.

IBM continues to improve the hardware and software costs of its mainframes with every announcement, making mainframe pricing more attractive. For example, in the July 12 announcement, the entry-level IBM z114 is listed at $75,000, 25% less than the z10 BC entry- level price, while delivering 18% higher performance per core. Some additional price reductions are:

- IFL: $55K from $75K
- zAAP/zIIP: $100K from $125K per engine.
- Memory: USD $1500/GB from USD $6000/GB.[4]

Additional savings can be achieved by lower maintenance costs for hardware and software in comparison to the System z10, and better channel granularity. The largest reductions are on the entry-level, making the z114 even more attractive for SMEs and new users. The internal network between the system z and the zBX yields additional savings by eliminating external network components.

[3] Solution Edition is a bundled offering of hardware, software and maintenance, all at a single, affordable bottom line price. Each Solution Edition is tailored to meet key business needs at the lowest cost.

[4] All prices mentioned are US list prices and may change depending on geography.

Scalability and performance Benchmarks

Core Banking Benchmark on zEnterprise

Core[5] banking applications are applications that require very high scalability and top security. Many of the major banking applications were developed in the 70s, are batch-oriented, and are complicated to change, which means that banks need to maintain their own teams of analysts and programmers. This encouraged SAP to deliver a core banking application in 2000 which offers much better flexibility and ability for change. The German Post Bank was the first bank to deploy it serving ca. 6 million customers, followed by other banks. Currently, the largest number of accounts on SAP core banking application is ca. 40 million at the Commonwealth Bank of Australia. The bank has selected SAP for Banking solutions based on SAP NetWeaver®. The solution portfolio provides banking-specific (transactional banking, CRM, risk management) as well as banking-relevant (financial accounting, human resources management and procurement).

The launch of zEnterprise created an opportunity for IBM to test the scalability and the performance of this hybrid infrastructure and SAP core banking workloads. A core bank system with a huge database of 150 million banking accounts was selected to stress locking, logging, and scaling aspects of DB2 for z/OS, and to see if zEnterprise had the performance characteristics to meet bank processing window requirements at that scale.

Benchmark results

Throughput of more than 59 million account postings per hour for day processing workload. Settled more than 37 million accounts per hour balanced in night processing scenarios.

The Benchmark Infrastructure

Benchmark infrastructure was designed to support data sharing and automated failover.

- 1xz196-M80 with two LPARs, each LPAR with 30 processors (as database server).
- 2x Coupling Facilities each with 8 processors (CPs).
- 5xDS8800 storage subsystems.
- DB2 version10.
- SAP Banking Services 7.0.
- 5 Blade centers, each with 14 POWER 7 blades (as application server) running AIX.

[5] CORE stands for Centralized Online Real-time Exchange. Gartner defines a core banking system as a back-end system that processes daily banking transactions, and posts updates to accounts and other financial records.

What can we learn from these benchmark results?

There are many conclusions and lessons from this benchmark but the three most important are:

1. The great synergy of the zEnterprise: System z for capacity and zBX for performance.
2. The ability of System zEnterprise with DB2 for z/OS to satisfy large bank future growth requirements
3. Large scalability in relatively small floor space. To achieve the same results on other platforms would require large number of servers.

SAP IS-U (Utility) Benchmark on zEnterprise

SAP IS-U is SAP's industry-specific solution of a customer-care application designed for utilities. Its uses include billing, price calculations, contract management, estimating load forecasts, etc.

The benchmark was requested by a large European utility company that was looking for an infrastructure to support billing of ca. 30 million customers in 20 days which translates to create 1.5 million bills per day in a 10 Hours window.

The Benchmark Infrastructure

Four tests were performed:

- z196 2817-M32-716 7 CP + 7 zIIPs, 100GB Memory, one LPAR - z/OS 1.11 (as database server). The mainframe configuration was the same for all tests.
- DB2 v10.
- 40 TB DB2 on DS8800, 128 GB Cache, 384 disks (300 GB, 15K RPM), RAID5 connected with 8 FICON channels.

- **Test A**: 5 POWER 7 LPARS (one for SAP-Central Service) and four for SAP-Application Server), each with 8 CPs and 32GB running AIX 6.1.connected by 10 Gbps external connection. The total number of SAP-as cores used was 4x8.
- **Test B**: POWER blades on zBX each with 7 Cores and 54 GB memory connected by internal 10Gbps connection, 1 FCP connection between the blades and the DS8800. Total number of SAP-AS-used cores 4x7.
- **Test C**: As above but the total number of SAP-AS-used cores 6x7.
- **Test D**: As above but the total number of SAP-AS-used cores 8x7.

Benchmark results

- Test A: 262 047 billings per hour. The required upload time was 8372 seconds.
- Test B: 261 568 billings/h (similar to A but with less cores). The required upload time was 7450 seconds (ca. 11% shorter than in test A)

- Test C: 358 905 billings/h.
- Test D: 426 630 billings/h.

What can we learn from these benchmark results?

These results demonstrate many benefits of zEnterprise, and the value of zEnterprise hybrid solutions in particular. The most important lessons:

1. Great (almost linear) scalability, which means investment protection without service-level reductions today or in the future.
2. The internal connection performance is better than the external alternative, compare the upload times of Tests A and B.
3. The average zIIP utilization in all tests was at least 15% higher than the CPU utilization, which demonstrates the very effective offloading of DB2 processing to a much more price-attractive portion of the mainframe (see the Total Cost of Ownership portion of this paper on page 10).
4. Hundreds of SAP work processes can be served by a single DB2 subsystem. No tuning was required in any of the four tests.

Conclusions

SAP ERP on System z has always been a solid enterprise platform; however, the zEnterprise platform now adds even more reasons to consider this option. zEnterprise raises the bar by offering an integrated system for heterogeneous hardware, as well as software platforms that address the major infrastructure requirements of businesses looking for security, business continuity, and performance. Practically any SAP application can run on a single zEnterprise system. The various blade technologies offer flexibility in selecting options for web applications. The *Unified Resource Manager* acts as a central point of control–a centralized governance system that can manage an underlying z/OS, Linux on System z, AIX on POWER, or Linux and Windows on System x under a single-management umbrella, thus simplifying system management at lower management costs. The dedicated private network eliminates the needs for external, security-vulnerable connections, reduces the number of hops, reduces latency, and eliminates the need for inter-platform encryption.

"All these benefits position the zEnterprise as an ideal platform to enable SAP infrastructure consolidations for organizations of any size looking to consolidate their SAP instances on the most suitable platform."

Active/Active GDPS and HyperSwap provide a unique solution to reach the highest level of business continuity and availability. New pricing options and skillful negotiations can price these solutions at an acceptable level without compromising on business requirements. A holistic security design protects the system from external and internal threats.

The July 12 announcements and price reductions open new options for existing users, as well as making the SAP on zEnterprise very attractive to current non-mainframe users.

All these benefits position the zEnterprise as an ideal platform to enable SAP infrastructure consolidation for organizations of any size looking to consolidate their SAP instances on the most suitable platform.

IBM's Global Technology Services provide migrations and deployment services, while IBM Finance can finance the deployments, the software, and the hardware (including third-party components).