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How to compete in today's marketplace with DB2 for z/OS

Roger Miller, DB2 for z/OS technical evangelist



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Unlock the business value of your information.

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April 16, 2009
Silicon Valley Lab, San Jose, CA

Today's economy requires that every dollar spent provides the highest possible return on investment, especially as it relates to your critical asset of data. IBM System z is serious about your investment. IBM's DB2 for z/OS helps you reduce cost and complexity in your IT infrastructure, simplify compliance, and leverage your core data assets. Join us for a very important conversation that covers why leveraging the latest version of DB2 is a protection for the future of that data asset and an investment into your success.

In this session, Roger Miller will discuss some of the more recent improvements in DB2 for z/OS and why they are important to your business. He'll cover how you can improve availability and performance, while reducing system usage and personnel costs. He'll also discuss some of the improvements that were made in the areas of scalability, security and compliance to address the critical challenges facing today's economy. Anyone trying to maximize their IT investment, coping with the challenges of security and compliance, or trying to optimize performance and gain a competitive edge in the marketplace must attend this session.

Roger is a DB2 for z/OS technical evangelist, architect, designer, writer, and factotum who has worked 30 years on many facets of DB2, ranging across performance, concurrency, availability, SQL, languages, install, and security. He often helps customers to use the product, answers many questions and presents frequently to user groups.

Agenda

- **Reducing cost and complexity**
- **Reducing risk**
- **Increasing value**
- **Resilience, availability, and security**
- **Performance and scalability**



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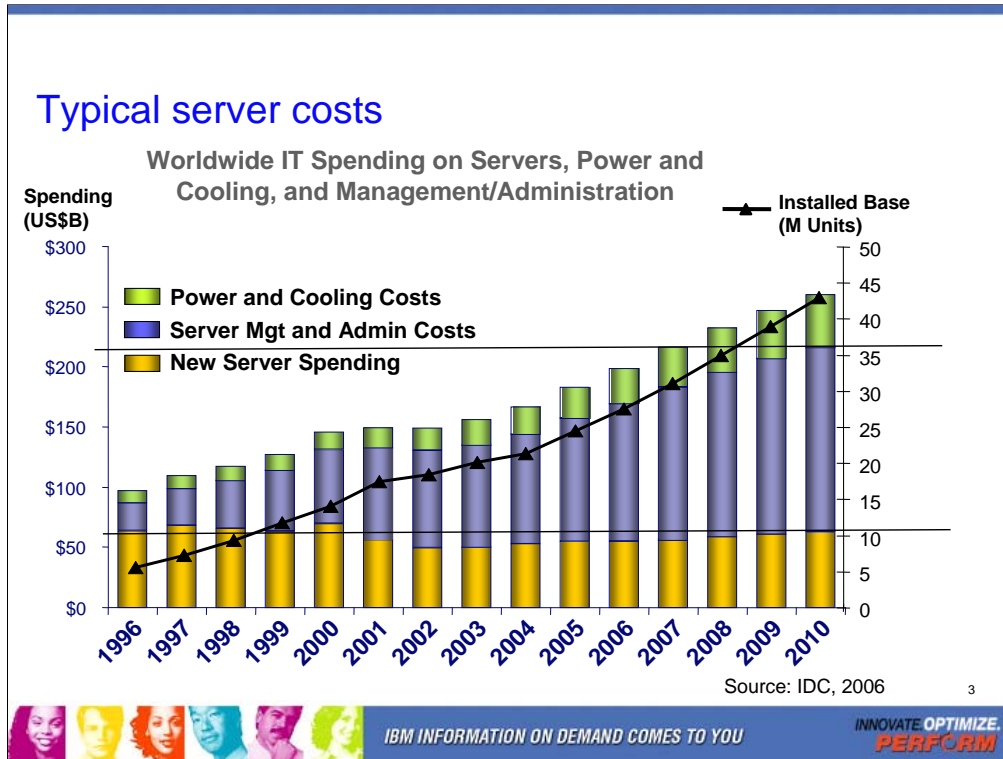


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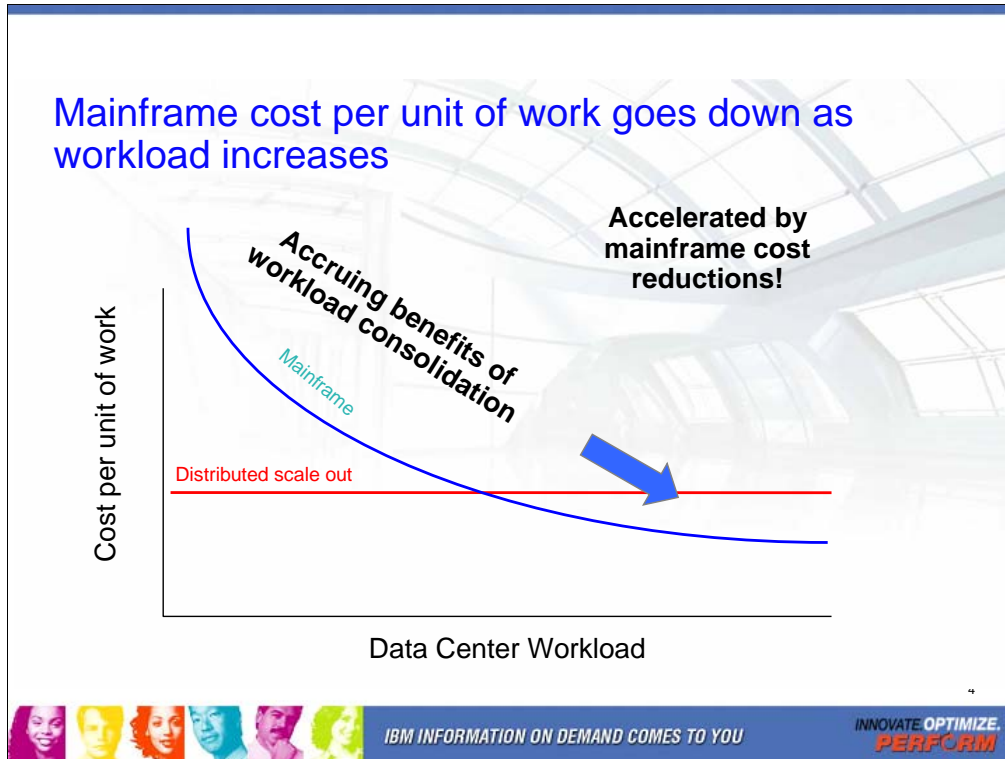
“Do more with less.” is a common demand now. Expect more to do and less resources to do it with in the coming years. What are your strategies for reducing costs and increasing value? One of the key techniques is direct reduction of costs and complexity. Technology provides some economies directly, and we need to take advantage of those opportunities. Reducing risk is another challenge. We can defer some work, but deferring often means increasing risks and costs over the longer term.

The larger opportunity in many cases will be increasing the value, helping manage the business better, improving the system resilience, performance and scalability.



The scale out of computing is a significant contributing factor to the growth in IT spending. New server spending has remained fairly constant. But as servers grow, so have the costs related to server management and administration, as well as, the power and cooling costs.

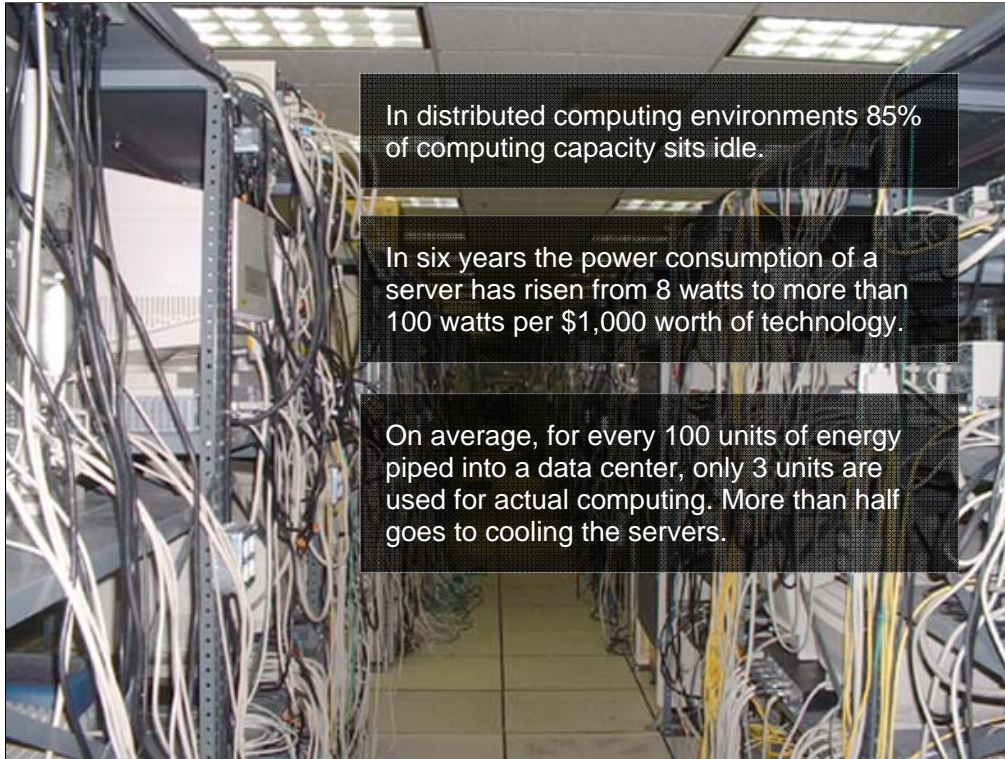
The largest fraction of the costs and the fastest growing are the management and administration costs, mostly people. Power and cooling costs have increased sharply recently, but then moderated. The longer term outlook is increased cost of power, so that the cost to buy a low cost processor is the same as a few years of power and cooling costs.



Costs on distributed systems generally scale out linearly. Take the number of processors or cores and multiply, with some discount.

As you can see, this is a contrast to the value proposition of mainframes. On the distributed machines, the cost per unit of work scales linearly as the workload grows... Whereas on the mainframe, the more you do, the cheaper it becomes per unit of work. If the decision makers truly look at the Total Cost Of Ownership (not just acquisition), this is a simple choice. The System z platform is the one to grow your business on.

As you grow, the new work is less expensive yet, driving down the average cost per unit of work.



In distributed computing environments 85% of computing capacity sits idle.

In six years the power consumption of a server has risen from 8 watts to more than 100 watts per \$1,000 worth of technology.

On average, for every 100 units of energy piped into a data center, only 3 units are used for actual computing. More than half goes to cooling the servers.

Let's take a look at power consumption. We generally spend about 50% to 100% more power on cooling than on processing. Today's power consumption is wasteful. Cost More effective virtualization and better efficiency are required.

This is not just a green issue, unless you count green as the color of money. It's one of being smarter, more efficient, and more cost effective. Some shops are seeing power as the limit to the scale of a data center.

System z can dramatically reduce Carbon Footprint and return green money

Example scenario: 1528 UNIX servers vs. 4x System z9 54-way frames

Environmentals	Current	Alt. Case
Total RackU	9,198	na
Racks	500.0	4.0
Total kW	2,203	41
Adjusted kWh/yr	19,396,862	360,956
Heat BTU/hr	5,038,017	93,752
CO2 tonnes /yr	8,341	155
Carbon tonnes /yr	2,276	42
RIPs /kW	425	2,400
RIPS / tonne CO2	112	634
W /m2	14,373	6,000
RackU / Server	6.0	2.0
Watts / Server	1,442	200

CO₂ Reduction = 27,073 Trees

* All performance information was determined in a controlled environment. Actual results may vary. Source: Scorpion Study results 2007



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Be green. Save money. This chart shows the CO₂ reduction effect, the environmental effect, of consolidating 1,528 Unix servers onto 4 z9 EC 54-way mainframes. z10 processors are more efficient yet, earning the green stripe. Sharing resources and virtualization for the past 40 years has provided a level of maturity in many areas. Save money for power and cooling costs.

[next page] What are we doing to help you hang on to your money? Cost and value are the bottom line. Total cost of ownership or TCO is a frequent conversation with executives and managers. Each of the resources has a cost, and the most costly one for customers is people costs. As the cost of computing continues to decline and the cost for people continues to rise, the future will be dominated by people costs. Many of the important changes in DB2 are to improve people productivity.

Processing costs are often the most visible charges. Some customers charge almost all costs back by processing. Processing costs continue to be reduced for general purpose processing, as CPU power increases. zIIP and zAAP specialty engines reduce the cost of processing power further. The traditional cost has been expressed in thousands of dollars per MIPS, and that figure would be roughly \$140 or less for specialty engines today. The latest change was the z10 zIIP, with the same cost as earlier specialty engines and roughly 58% more processing power. z10 BC takes one more step, reducing cost more than power.

DB2 for z/OS Lowering TCO

- **Maximum value for dollar investment**

- Hardware pricing
 - CPU saving specialty engines (zIIP, zAAP..)
 - Compression of disk space (data, index)
- Software pricing
 - Reduction for tiers
 - Parallel Sysplex aggregation
 - z990, z9, z10 technology dividend
 - 10% reduction in charge units for each step
 - zNALC, Value Unit Edition, Subcapacity pricing



- **CPU + Memory + I/O and disk + Software + Energy and floor space + People = Improved Total Cost of Ownership (TCO)**

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Software costs are higher than hardware costs for most customers, generally in a range of three to ten times higher. This is the reason that specialty engines are so attractive, as the software running on them does not incur software charges. Unit software costs continue to decline in many ways. Software charges have many options, but some of the basic tenets are consistent for most. System z software is charged for the processing capacity of the machine, taking into account multiprocessor effects, rather than using a linear scale. Larger amounts of processing power reduce the unit cost by more than 90%. The z990, z9 and z10 generations have each reduced the charging units by 10% over the prior generation. Changing from z900 to z10 processors would reduce the software charge units by about 28% for the same processing power. Additional options for reducing software charges include parallel sysplex charging, subcapacity pricing, zNALC pricing, and the new Value Unit Edition. I/O costs include the disk space and the transfer to the processor. Both costs are addressed by the work to use System z effectively. Compression for data uses z/Architecture instructions to be efficient, with a solid track record since 1993 and improved performance in the latest generations. Index compression in DB2 9 adds to the savings.

The key for pricing is the value. DB2 for z/OS delivers a very high quality of service. The service is shared, so that administration time is reduced. The amounts of processing, memory, disk and people can be reduced by effective sharing, delivering the best value for the money.

Deep Synergy with System z

DB2 delivers quality of service of z/OS & System z

Key integration points include:

- Hardware data compression
- Data sharing (availability and scale out)
- Unicode conversion
- Encrypted TCP/IP communication (SSL)
- Encrypted data
- Sorting
- zIIP specialty engines
- 64-bit addressing and large memory
- z/OS Workload Manager
- z/OS Security Server (RACF)



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We'll discuss some of the changes in DB2 for z/OS that use the System z platform more effectively. DB2 9 for z/OS adds more value and subtracts more cost through synergy with System z. The System z10 and z9 processor improvements for DB2 are the zIIP and the Business Class and Enterprise Class processors. DB2 9 remote native SQL procedures are enabled for zIIP processing. DB2 9 adds IPv6, SSL and decimal float and BIGINT data types, with enhancements for Parallel Sysplex, backup and restore, added security and encryption, more Unicode with collation, and uses the WLM in new ways. Channel enhancements (MIDAW) and improved DS8000 performance were included with the System z9 announcements. DB2 uses the latest improvements in hardware and operating system to provide better performance, improved value, more resilience and better function.

DB2 benefits from large real memory, faster processors, specialty engines, and better hardware compression. DB2 uses Parallel Access Volume and Multiple Allegiance features of the IBM DS8000 and Enterprise Storage Server™. FlashCopy® can be used for DB2 backup and restore. DB2 makes unique use of the z/Architecture™ instruction set, and recent instructions provide improvements in reliability, performance and availability. DB2 continues to deliver synergy with hardware data compression, FICON™ (fiber connector) channels, disk storage, advanced networking function, and Workload Manager (WLM). The Business Value and Performance Topics books discuss working with System z in depth.

Helping to drive down the cost of IT *Now even more workloads can benefit from zIIP*

- Integrate data across the enterprise, optimize resources and lower the cost of ownership
 - Centralized data serving
 - Serving XML data
 - Use by ISVs
 - New HiperSockets™ for large messages
 - New IBM GBS Scalable Architecture for Financial Reporting™
- zIIPs offer economics to help you
 - PLUS zIIP price same for z10 EC as z9 EC



zIIP can help to integrate data across the enterprise by lowering the cost of ownership for eligible data and transaction processing workloads

Centralized data serving_– First to exploit zIIP were workloads such as BI, ERP, and CRM applications running on distributed servers with remote connectivity to DB2® V8

Network encryption_– zIIP becomes an IPsec encryption engine helpful in creating highly secure connections in an enterprise

Serving XML data_– zIIP is enabled for XML parsing, first to exploit this was inserting and saving DB2 9 XML data over DRDA® . See this paper for more detail.

DB2 9 and z/OS System Services Synergy Update,
<http://www.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP101227>

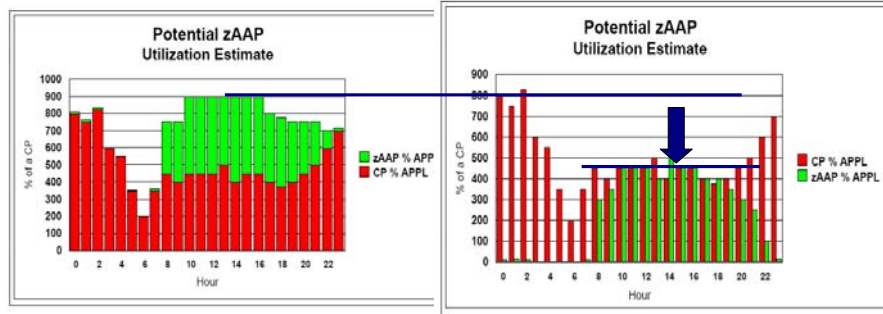
Remote mirror – zIIP becomes a data mirroring engine with zIIP assisted z/OS Global Mirror function (zGM, formerly XRC) helpful in reducing server utilization at recovery site (with z/OS V1.8 and above)

Exploiting of zIIPs by ISVs zIIPs offer economics to help you

The newest changes allow HiperSockets to be use zIIP for large messages, such as DRDA data and for financial reporting.

PLUS zIIP price is same for z10 EC as z9 EC and we offer no charge MES upgrades when moving to new technology

Why do zIIPs, zAAPs and IFLs Reduce Cost?



1. **Hardware costs:** By moving workload from general purpose processors to zIIP, zAAP and IFL processors (higher cost to lower cost processors).

2. **Software Costs:** license/maintenance costs based on number of and usage of general purpose central processors. Specialty engines can reduce number of CP's.

No z/OS software charges based on zIIP, zAAP and IFL processors or usage.

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zIIPs and zAAPs do not add functional capabilities, but they do address hardware and software costs. In addition to being lower cost processors for the specialty purposes, they allow you to reduce the license and maintenance cost for software on z/OS, as there is no z/OS software charge for processing running on zIIP, zAAP or IFL processors.

DB2 for z/OS & IBM zIIP value

Portions of DB2 V8 and **DB2 9 (blue)** workloads may benefit from zIIP*:

ERP, CRM, Business Intelligence or other enterprise applications

- Via DRDA over a TCP/IP connection
- **DB2 9 for z/OS Remote native SQL procedures**
- **DB2 9 XML parsing**



Data warehousing applications*: Large parallel SQL queries

DB2 9 higher percentage of parallel queries eligible for zIIP

DB2 Utilities LOAD, REORG & REBUILD maintaining index structures

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DB2 9 uses zIIP in two new ways, remote native SQL procedures and increased use of parallelism. See IDUG Europe 2007 presentation F06 by Terry Purcell, "Tuning your SQL to get the most out of zIIPs". Obtain this session from IDUG online Technical Library by searching for code EU07F06.

The zIIP is designed so that a program can work with z/OS to have all or a portion of its enclave Service Request Block (SRB) work directed to the zIIP. The above types of DB2 V8 work are those executing in enclave SRBs, of which portions can be sent to the zIIP. Not all of this work will be run on zIIP. z/OS will direct the work between the general processor and the zIIP. The zIIP is designed so a software program can work with z/OS to dispatch workloads to the zIIP with no anticipated changes to the application – only changes in z/OS and DB2. IBM DB2 for z/OS version 8 was the first IBM software able to take advantage of the zIIP. Initially, the following workloads can benefit: SQL processing of DRDA network-connected applications over TCP/IP: These DRDA applications include ERP (e.g. SAP), CRM (Siebel), or business intelligence and are expected to provide the primary benefit to customers. Stored procedures and UDFs run under TCBs, so they are not generally eligible, except for the call, commit and result set processing. DB2 9 remote native SQL Procedure Language is eligible for zIIP processing. BI application query processing utilizing DB2 parallel query capabilities; and functions of specified DB2 utilities that perform index maintenance. For more, see <http://www.ibm.com/systems/z/ziip/>

The DB2 9 and z/OS System Services Synergy Update paper discusses recent XML benchmark measurements and performance information.

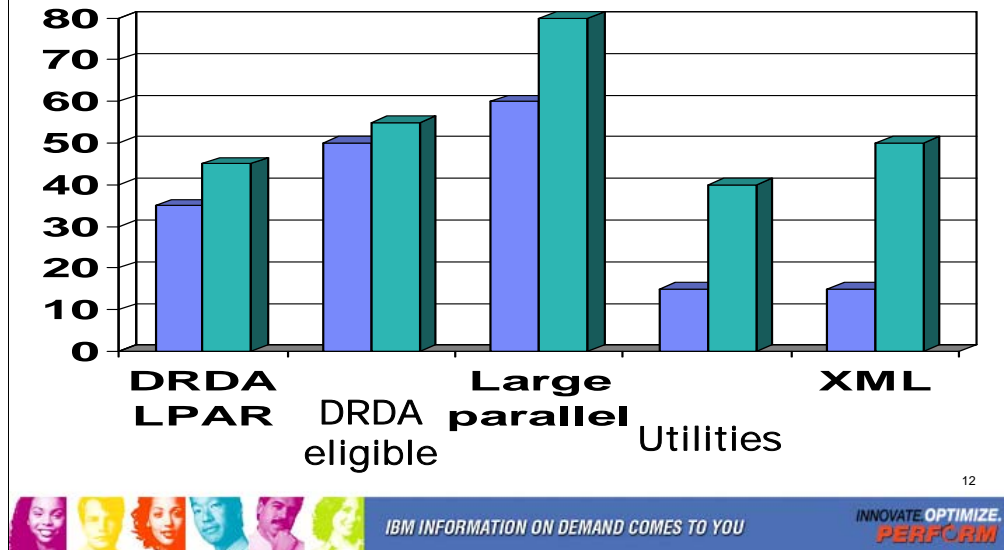
<http://www.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP101227>

DB2 9 for z/OS remote native SQL procedures are described in this paper, showing scalability up to 3193 transactions per second for SQL procedures and redirect to zIIP of over 40%

<http://www.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/TD104524>

* zIIP allows a program working with z/OS to have all or a portion of its enclave Service Request Block (SRB) work directed to zIIP. Above types of DB2 work are those running in enclave SRBs, of which portions can be sent to zIIP.

How much CPU gets redirected typically?



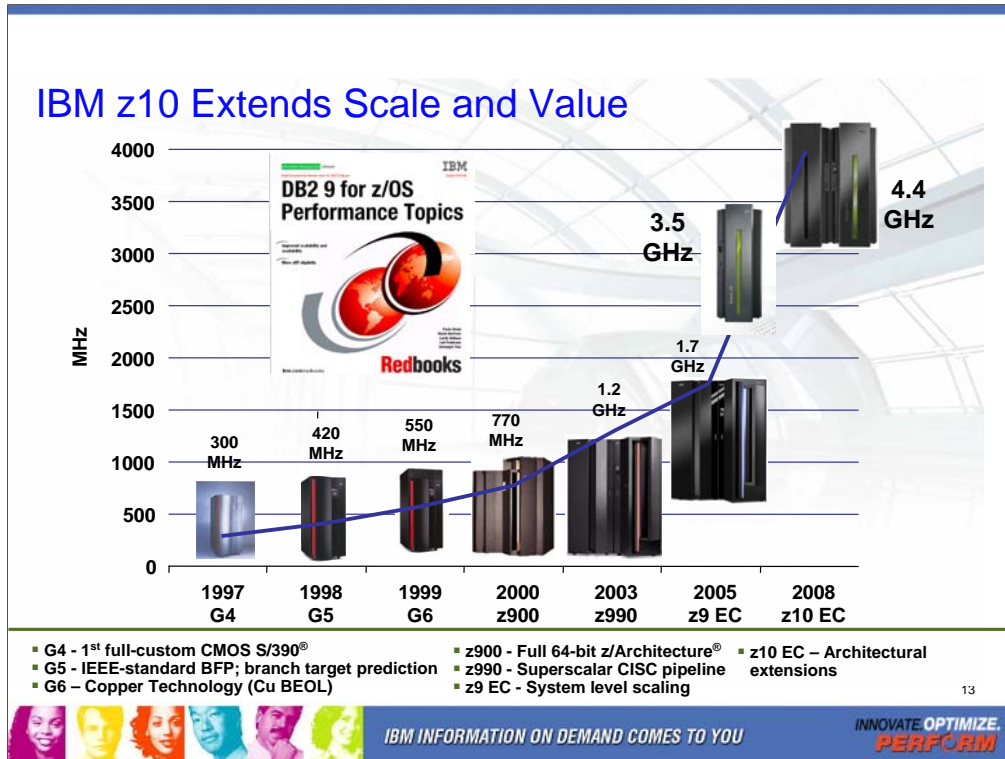
The range of processing redirected to zIIP and zAAP ranges widely. For some of the example workloads tested, this chart shows common ranges. With different workloads, your numbers will vary. The largest redirection is for large parallel queries, where as much as 80% of the CPU time is redirected. Some large parallel queries cannot be processed entirely in parallel, so the redirect percentage drops. When measuring the full LPAR, with work that cannot be redirected, such as operating system and performance monitors.

The range of utility redirection is large, depending upon the percentage of index processing. Most utility processing is not during the peak time, so this part of work is not as important. The utility CPU time is reduced in DB2 9, and the amount redirected is also reduced.

z/OS XML System Services consumes approximately 15% to 50% of total CPU time in measured XML insert or LOAD operations. This portion of CPU time is eligible to exploit zAAP redirection. The amount of CPU time for z/OS XML System Services will vary widely for other applications, based on the document size, its complexity, and number of indexes defined on XML tables.

See web resources and papers noted at the end of this presentation:

<ftp://ftp.software.ibm.com/software/data/db2/zos/presentations/overview/ziip-zaap-specialty-engines-idug-au-2008-miller.pdf>



The design of the IBM System z10™ processor chip is the most extensive redesign in over 10 years, resulting in an increase in frequency from 1.7 GHz (z10 EC) to 4.4 GHz on the z10 EC. It is designed for secure data serving, yet also was enhanced to provide improvement enhances for CPU intensive workloads. The result is a platform that continues to improve upon all the mainframe strengths customers expect, yet opens a wider aperture of new applications that can all take advantage of System z10s extreme virtualization capabilities, and lowest TCO versus distributed platforms.

See the DB2 9 for z/OS Performance Topics book, SG24-7473, for the latest information about DB2 performance on the z10. A range of lab measurements are provided in section 4.3 of the September 2008 update. Watch for more updates.

IBM System z10 Benefits for DB2

- **Faster CPUs, more CPUs, more memory**
 - 50% more n-way performance “on average”
 - 62% more uniprocessor performance
 - 70% more server capacity (54->64 CPUs)
 - Up to 64 CPUs, z/OS 1.9 needed for 64-way in a single LPAR
 - Up to 1.5 TB, z/OS 1.8 needed for >256G in a single LPAR
- **Infiniband Coupling Facility links**
- **New OSA-Express3, 10 GbE for faster remote apps**
- **HiperDispatch**
- **Hardware Decimal Floating Point facility**
- **1MB page size (DB2 X plans to exploit)**
- **50+ instructions added to improve compiled code efficiency (DB2 X plans to use)**



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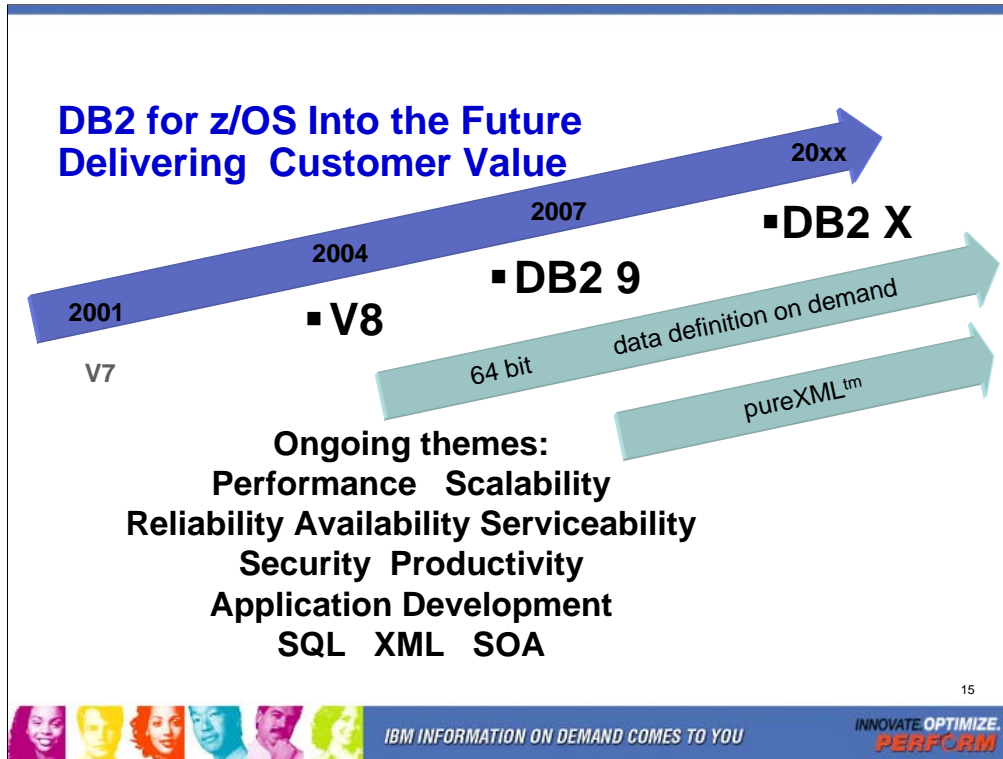
The new z10 has faster processors and more processors. One early measurement showed 40-50% throughput improvement or approximately 30% CPU time improvement with z10 compared to z9.

Larger memory: DB2 users can potentially see higher throughput with more memory used for DB2 buffer pools, EDM pools or SORT pools.

Improved IO: improvements in the catalog and allocation can make the large number of data sets much faster and easier to manage. Disk IO times and constraints can be reduced.

Substantial improvements in XML parsing can result from use of the zIIP and zAAP specialty engines. The z10 zIIP and zAAP engines are much faster at no additional cost. The zIIP processors can be used for XRC processing.

HiperDispatch: Only available on z10 EC. Combination of z/OS software and firmware. Minimum z/OS R1.7 + IBM zIIP Web Deliverable Support for z/OS V1.7 to enable HiperDispatch. Single HIPERDISPATCH=YES z/OS IEAOPTxx parameter dynamically activates HiperDispatch



DB2 for z/OS V7 became generally available (GA) March 2001, and V8 delivered three years later, March 2004. DB2 9 became generally available in March 2007, three more years. We expect the next version will be roughly 3 years from DB2 9 GA to DB2 10 or DB2 X or whatever the name becomes, but the timing and packaging may change too. The themes for future versions will continue to focus on core platform strengths of performance, scalability, reliability, stability, availability, resilience, and security. PureXML and Schema evolution or data definition on demand will be ongoing for a long time. In contrast, most of the 64 bit evolution should be completed in DB2 X. The key interfaces for customers and vendors expand for both XML and for SQL. Information is a key leg of the SOA platform, and DB2 for z/OS provides many advantages for data management in SOA. Standards, interoperability, portability and security along with secure access using the latest technologies are key touch points. Productivity improvements for application developers and for database administrators are very important as data grows in scale and complexity.

DB2 9 for z/OS field update

- **DB2 9: Climbing Sharply**
 - 33% of Top 100 27% of Top 200
 - Over 450 customers
 - Big push 2H08; Continuing push in '09
- **How's the Quality (compared to V8)?**
 - Lower overall PMR volume
 - Less Severity 1 APARs
 - Lower PE rate
- **DB2 V8: Migration finishing in most of world**
 - 100% of Top 100 Over 99% of Top 200
 - V7 End of Service: June 30, 2008
 - V8 Withdrawal from Marketing
 - Announced: Dec. 2, 2008
 - Effective: Sept. 8, 2009



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Now that DB2 9 has been generally available in the field for over 2 years, let's compare with V8 at the same point. For almost all of the key quality measures, DB2 9 is better. The most important issue for many customers is PTFs in Error (PEs), and the rate is lower on DB2 9. The PMR volume is lower and the number of field severity 1 problems is lower. V7 was widely regarded as a high quality version, and DB2 V8 total field experience is better than V7, with DB2 9 as the best of the three.

The largest DB2 customers have moved to Version 9. All of the largest 100 customers are running Version 8, and many large customers are implementing DB2 9 development, moving to production.

Part of the improvement in overall quality measures is due to more rigorous testing. Some of the improvement is due to the reduced amount of new function added in the service stream. Still these numbers represent the averages, and we know that our customers are not average. Individual customer results are highly skewed, so the average numbers might not reflect your individual experience.

DB2 V7 is now out of service after seven years of general availability. If you are still there, it is time to move now. V8 is being withdrawn from marketing this year.

DB2 for z/OS Version 8 *Extending the limits*

SQL OLTP Leadership	<ul style="list-style-type: none">• Lengths of table names, columns, statements• Cursor scrolling• New expressions & recursion• Predicates & diagnostics
Performance & scalability	<ul style="list-style-type: none">• Index, materialized query tables,• Faster, more efficient I/O• Reduce CPU with multi-row fetch & insert• More storage, partitions & log
Database changes without an outage	<ul style="list-style-type: none">• Add a new partition or rotate partitions• Extend columns• New backup and restore system
Integration with platform and applications	<ul style="list-style-type: none">• System z, z/OS & Total Storage• Middleware stack• SAP, PeopleSoft, Siebel and others



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Version 8 brings new synergy with the System z hardware, using z/OS 64-bit virtual addressing capabilities. V8 improves data support, application development, and query function enhancements for e-business. It also builds on the traditional System z and DB2 characteristics of availability, exceptional scalability, and performance for the enterprise database management system of choice. V8 has been re-engineered for e-business on demand, with many fundamental changes in architecture and structure. Key improvements enhance scalability, application porting, security, architecture, and continuous availability. Management for very large databases is made much easier, while 64-bit virtual storage support makes management simpler and improves scalability and availability. This new version breaks through many old limitations in the definition of DB2 objects, including SQL improvements, longer names for tables and columns, longer SQL statements, enhanced Java and Unicode support, enhanced utilities, more log data sets, more partitions, and many more advantages.

Many barriers that limit our customers are removed: using 64 bit memory, providing consistent table and column name lengths, allowing 2 megabyte SQL statements, 4096 partitions, and three to ten times the log space. Improved scalability and availability delivers in tripling active log size and ten times the archive logs. Allowing sixteen times the number of partitions allows a table to use one partition per day for eleven years.

Being able to make database changes without an outage, such as adding a partition, is a breakthrough for availability. Alter your table and go, no need to drop and redefine.

DB2 9 for z/OS *Serving the Most Demanding Data Goals*



SOA Enablement

- *pureXML*
- *Optimistic locking for WebSphere*
- *LOB performance, usability*



Dynamic Warehousing

- *Many SQL improvements*
- *New built-in OLAP expressions*
- *Dynamic index ANDing*
- *Histogram statistics*
- *Optimization Service Center*



Simplification, Reduced Cost

- *Index compression*
- *Partition By Growth tables*
- *Cloned tables*
- *Volume based backup / recovery*



Workload Consolidation

- *More online schema changes*
- *Online REBUILD INDEX*
- *Trusted context and ROLES*
- *Parallel Sysplex cluster improvements*

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One of the key initiatives of V8 was online schema evolution, and that theme is expanding and changing to be data definition on demand. These are key improvements for resilience. One of the important changes is to be able to replace one table quickly with another. Another is to be able to rename a column or an index. A new type of table space combines the attributes of segmented and partitioned, without a partitioning key. Rebuild index can be run with much less disruption. Online table space reorganization for a few partitions is improved a lot, removing the BUILD2 phase for all types of secondary indexes. Table space and index logging can be altered. Changing DB2 early code does not require an IPL.

Many other improvements help with performance, with scalability and with availability. Index on an expression can be combined with caseless comparisons to improve text search. Improved insert rates can result from improved latching of the log data. Significant reductions in cpu usage are provided with new utilities.

Today's complex applications include both transactions and reporting, so performing both well is imperative. The key improvements for reporting are optimization enhancements to improve query and reporting performance and ease of use. More queries can be expressed in SQL with new SQL enhancements. Improved data is provided for the optimizer, with improved algorithms. Improved cpu and elapsed times can be achieved with the FETCH FIRST clause specified on a subquery. The INTERSECT and EXCEPT clauses make SQL easier to write.

If you are not on DB2 9, look what you are missing!

Availability, Scale & Resiliency	More Online Schema Changes Volume Level Backup & Recovery	Business Flexibility Faster, Cheaper, Granular Recovery
Compliance & Security	Database Roles & Trusted Context	Efficient Auditing & Compliance
Easier Application Development	PureXML	Streamlined Data Integration
OLTP & Warehousing	Query Optimization	Highly Available, Secure Data
Reduce Cost of Ownership & Skills	Index Compression	50% Disk Savings

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What are you missing if you are not running DB2 9 today? CPU savings is first on the list. Disk space savings is second. Index compression is added to the data compression used by almost every customer. The biggest savings come in productivity for people. Many changes that can be done with an ALTER or an online utility in DB2 9 require outage time in earlier versions. Backup and recovery has many improvements.

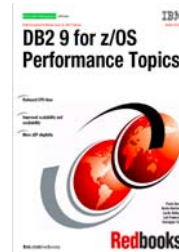
Security can be more flexible and more robust.

XML can be implemented in the DBMS, rather than separately, so that integration can be implemented, instead of needing a huge separate project later.

Improvements in SQL and optimization improve productivity for query users and programmers.

DB2 9 cost savings: Selected features save CPU or storage

- Index compression
- zIIP and SQL native stored procedures
- CPU reductions in most utilities: LOAD, REORG, RUNSTATS, COPY, RECOVER, CHECK, ...
- INSERT performance enhancements
- Improved performance for VARCHAR
- Improve LOB performance and manageability
- DDF 64-bit shared memory
- 10 to 15% improvement in virtual storage
- Improved query performance
- Enhanced index split, larger pages and sequential key insert
- See much more in the DB2 9 Performance Topics Redbook, SG24-7473



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Index compression can save around half of the disk space used for indexes. This is especially helpful in a data warehousing environment.

Utility CPU time reductions are very substantial, with about 20% to 30% reductions reported by early customers. Here are the lab benchmark highlights, with * indicating that the savings are in index processing.

10% to 20% in Copy, Recover table space / index*

5% to 30% in Load*, Reorg*, Rebuild Index*

20% to 60% in Check Index*

35% in Load Partition*

30% to 40% in Runstats Index*

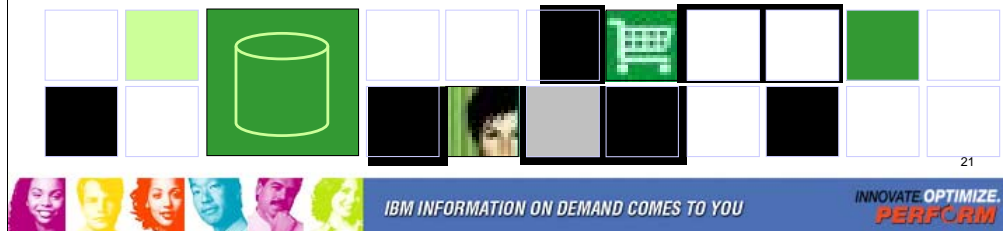
40% to 50% in Reorg Index*

70% in Load Replace Partition with dummy input

See much more in DB2 9 Performance Topics book, SG24-7473

Performance improvements and tuning

- Use of zIIP and zAAP
- Monitor performance, but not too much
- Parameter changes
- Buffer pools and other storage
- New versions and service



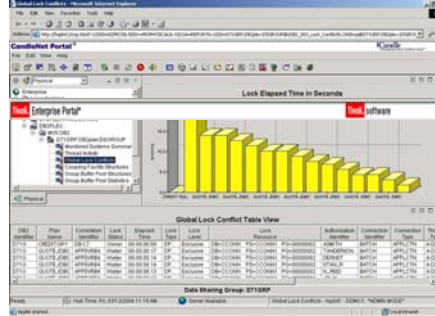
The subsystem tuning options can make a significant difference, although the database administration and application programming options generally provide larger improvements.

New versions and service can make a significant difference in performance. Some of the subsystem parameters can help, particularly when there is a bottleneck, such as memory. Use of zIIP and zAAP engines can help with costs for the appropriate workloads. Thread reuse can help, when used appropriately.

Performance monitoring is needed, but too much monitoring can require more resources than savings. How many performance monitors are being used concurrently?

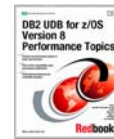
Tivoli OMEGAMON XE for DB2 PE on z/OS V4

- Improved ability to monitor and manage mainframe based applications through a single integrated solution
- Required for DB2 9
- Familiar interfaces from DB2 PE and OMEGAMON XE products provides easy migration
 - DB2 z/OS V8 & 9 new function
 - DB2 Connect reporting / monitoring
 - Performance warehouse (historical data mining)
 - DB2 to CICS transaction linking
 - History monitoring
 - Event exceptions
 - Threshold checking



<http://www.redbooks.ibm.com/redpieces/abstracts/sq247224.html>

<http://www.ibm.com/software/tivoli/products/omegamon-xe-db2-peex-zos>



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We merged two leading products and we also merged the development organizations. IBM Tivoli OMEGAMON XE for DB2 Performance Expert and Performance Monitor became generally available in December 2005. The Tivoli naming notes the tight integration with the rest of the suite of integrated monitors from IBM. In this new version you will see the same user interfaces that were available in the OMEGAMON XE for DB2 product as well as in the DB2 Performance Expert and DB2 Performance Monitor. This provides an easy migration path to the converged product. For DB2 9, customers must have Omegamon PE V4.

You get the ability to monitor DB2 Connect, allowing you to track the communications between DB2 Connect and DB2. This is critical in this day of more and more distributed clients. It gives a complete picture of your end to end performance and resource usage. Many of you I'm sure have experienced situations where resource or performance issues have been difficult to diagnose in terms of origin. Is it the web server? Is it DB2? Is it the network? This tool can save you time and money in quick problem diagnosis

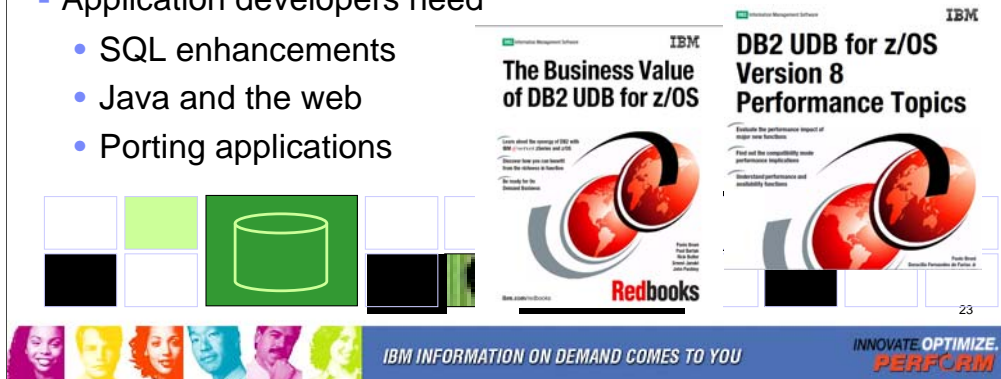
You get the value of a performance warehouse for additional long term analysis of your performance data. You can query or take action (set automated tasks) against this warehouse. You get historical reporting – the near term history function continuously captures reporting data. A good example would be using this information to review the performance of threads that have ended. You also get tremendous flexibility in setting alerts and taking action for event exceptions based upon thresholds you select. Using this tool you can identify system bottlenecks such as locking conflicts and deadlocks fast and easy. This is a great story for our users and new users. Be sure to look at this product if you have one or both products or if you just want the best DB2 performance monitor. See the new redbook and the web page for much more detail.

<http://www.redbooks.ibm.com/redpieces/abstracts/sq247224.html>

<http://www.ibm.com/software/tivoli/products/omegamon-xe-db2-peex-zos>

Why Migrate to DB2 for z/OS V8? It's better!

- Business needs
 - Reduce risk
 - Improve business stability
 - Availability
- Database Administrators need
 - Scalability, very large database
 - Queries and data warehouses
 - Performance improvements
- Application developers need
 - SQL enhancements
 - Java and the web
 - Porting applications



V8 is the production standard for almost all large customers today. As V7 is out of service, your risks for running on older versions is significantly higher. V8 offers significant improvements. Value and effort vary widely for different customers and most of the improvements fit more than one category, so this list is not ordered.

Greatest Hit 1: High availability

One of the biggest steps for database administrators in continuous availability is online schema evolution, with the ability to add partitions and make about 20 changes with ALTER. New backup and recovery utilities are useful for disaster recovery and will be the primary backup technique for some customers. Improvements in utilities include more online performance and better usability.

Greatest Hit 2: Scalability or very large databases

Separate partitioning and clustering allows two dimensional clustering with more effective IO. New index options provide more efficient access. The maximum number of partitions is raised to 4096. The availability and optimization improvements are critical for very large databases. The ability to use more memory, more effectively is key for scalability.

Greatest Hit 3: Java and the web

Improvements in the SQLJ and JDBC support, a new Java Universal Driver, enhanced Unicode support, integration with WebSphere and new XML functions make Java and web applications more robust and more productive.

Greatest Hit 4: Queries and data warehouses

Optimization changes provide the best performance improvement opportunities in V8. Faster response and reduced processing time come from improved optimization and better information for the optimizer. New database design options for indexes, clustering and materialized query tables provide more gains. Warehouses often need to have the new rotate partition capability.

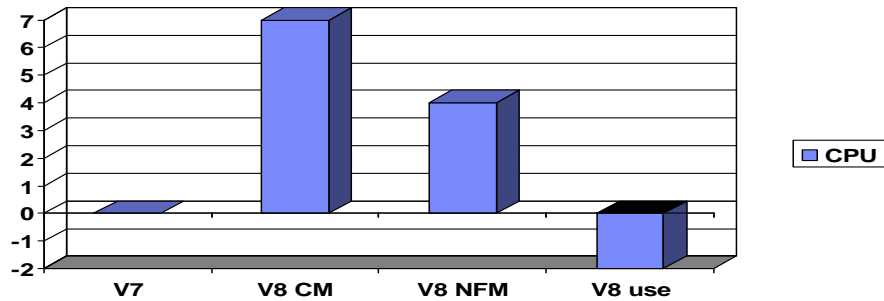
Greatest Hit 5: Migrating or porting applications from other platforms

Many SQL enhancements provide better compatibility with the DB2 family and with the industry. If customers develop on Windows, Unix or Linux, and then move to z/OS, the process is much easier. Early customers reported success at porting applications.

Greatest Hit 6: Application packages: SAP, PeopleSoft, Siebel, etc. ...

About 50 improvements, including everything mentioned in the "Greatest Hits" section, are provided for most of the key vendor packages. SAP R/3 4.6 and PeopleSoft PeopleTools 8.45 are already certified for V8, less than four months after general availability.

DB2 V8 best practice performance plan scenario



Data sharing Better statistics DB design adjustments
 REBIND Cluster, index
 PGFIX(YES) application changes
 zIIP multirow fetch & insert
 zparms SQL adjustments
 Your situation will vary. Less CPU is better.

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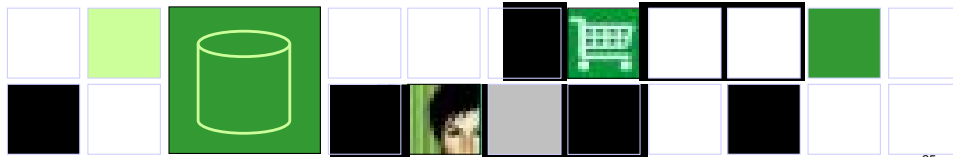
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Your situation and mileage will vary, but this is a common shape for a V8 performance plan, starting with zero for the V7 base line. When you move to V8, CPU time generally increases from 5% to 10%, shown here as 7. Start with long term page fix for buffer pools with high numbers of pages read and written. Reorg and collect improved statistics for non-uniform distribution of data on non-indexed columns. The V8 CM performance plan REBINDs the primary packages, and adjusts DSNZPARMs. The CM REBIND process provides most of the improved access paths. Data sharing batching helps in CM. During CM, a zIIP is added if your peak work load includes DRDA SQL, parallel query or LOAD, REORG and REBUILD. In moving to NFM, some additional DSNZPARMS are adjusted and REBIND all plans and packages. Database designs start taking advantage of new clustering & indexing options, such as NOT PADDED for large varchar indexed columns. After making the design changes, REORG the data; REORG or REBUILD the indexes; get improved statistics & REBIND. The data sharing group is quiesced, and protocol 2 locking is used. V8 use takes more advantage of the V8 performance improvements: MQTs, DPSI, more not-padded indexes, multi-row Fetch, cursor Update, cursor Delete, & Insert. Use other SQL improvements to reduce V8 CPU, less than V7. The work may grow, but some of the growth uses the zIIP.

Why Migrate to DB2 9 for z/OS?

- Business needs
 - Reduce CPU time & disk space
 - Improve business agility
 - Service Oriented Architecture
- Application developers need
 - Powerful new SQL enhancements
 - Portability with SQL and data definition compatibility
 - PureXML for a powerful SQL and XML interface to XML data
- Database Administrators need
 - Improve availability and performance
 - More flexible security and easier regulatory compliance
 - Better web application & data warehouse function and performance
 - LOB function, performance, usability



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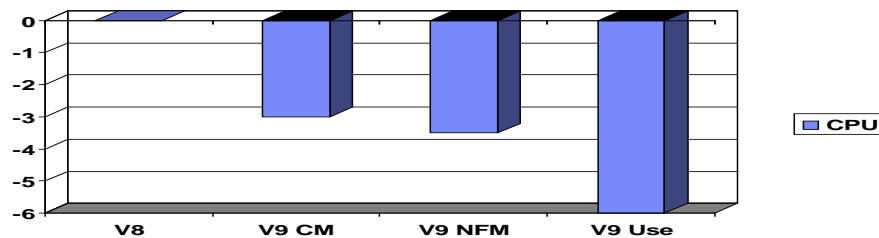
DB2 9 has a lot for everyone. Here are just a few of the highlights.

The business needs include CPU cycle reductions that deliver in most utilities, improved query optimization, improved business agility via faster implementation cycles, and new pureXML™ that builds a strong foundation for SOA and XML initiatives. Kevin Campbell, an Application Architect at Univar USA said it better than I can, “This is not a bolt-on or band-aid approach, DB2 9 for z/OS is XML without compromise.”

Database Administrators (DBAs) need improved database availability and performance including LOBs, reorganization, backup and recovery, and partitioning enhancements. DBAs also get more flexible trusted network context and role-based security to help with regulatory compliance. A wide range of enhancements improve ERP application and data warehouse functionality and performance. Large object (LOB) function is added with file reference variables and REORG, while performance is improved.

Application developers are most excited by PureXML, which adds a powerful SQL and XML interface to access XML data stored in a native format. Application developers need powerful new SQL enhancements including MERGE and TRUNCATE statements, INTERSECT and EXCEPT set operations, and spatial support for geographical data. Text handling is improved with the XML changes, many new built-in functions, and an upcoming text server. Improved SQL and data definition compatibility with other DB2 platforms makes porting much easier.

DB2 9 z10, z9, z890 & z990 performance plan scenario



Utilities	DB design adjustments
Histogram statistics	Index improvements
REBIND	application changes
DSNZPARMS	native SQL procedures
	SQL adjustments

Your situation will vary. Less CPU is better.
z800 and z900 expect +5% to +10% CPU

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If you have a z9, z990 or z890, this is expected to be a common shape for a DB2 9 performance plan, starting with zero for the V8 baseline. When you first move to DB2 9, total DB2 CPU time generally decreases from 0% to 5% for z9, z890 and z990 customers, shown here as a first step -3%. Utility CPU reductions help immediately. Some work will be about the same (+/-3%). Start with reorgs and collect improved histogram statistics when useful. The DB2 9 CM performance plan REBINDs the primary packages and adjusts DSNZPARMS. The REBINDs provide improved access paths. On z800 or z900 the initial cpu expectation is +5 to +10% regression, more if there are many columns, so tuning is more important.

In moving to NFM, some additional DSNZPARMS are adjusted and all plans and packages are rebound. The DB2 9 use line takes wider advantage of DB2 9 performance improvements. Database designs start taking advantage of new indexing options, such as compression, index on expression and larger pages. After making the design changes, REORG the data and REORG or REBUILD the indexes, get the improved statistics and REBIND. Native SQL procedures, added use of zIIP, and improved SQL continue the improvements in this phase.

Scenario: Customer mix of DB2 CPU time is 30% in utilities, 70% in SQL access. With 10% improvement for the utilities, we get a -3% net, assuming that SQL is the same as before. With optimization improvements, another -1/2% improvement shows up in DB2 9 NFM. Then as design adjustments, reorgs and rebinds are performed, we get improvements from varchar improvements, native SQL procedures and improved SQL, another -3%.

DB2 9 Easier Application Development

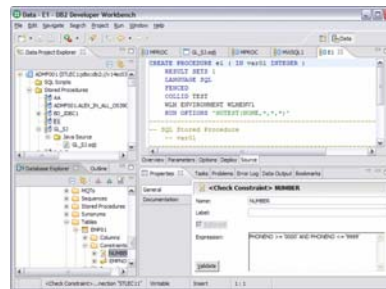
SOA and XML

Simplify development process

Improve performance

Numerous SQL enhancements

- Merge / Truncate
- Select from update, delete & merge
- Instead of triggers
- BIGINT & DECIMAL FLOAT
- New Built-in functions e.g. SOUNDEX
- DDL porting improvements
- Optimistic locking
- Developer Workbench
- Spatial or geographic data
- Text Search server included
- Native SQL Stored Procedures



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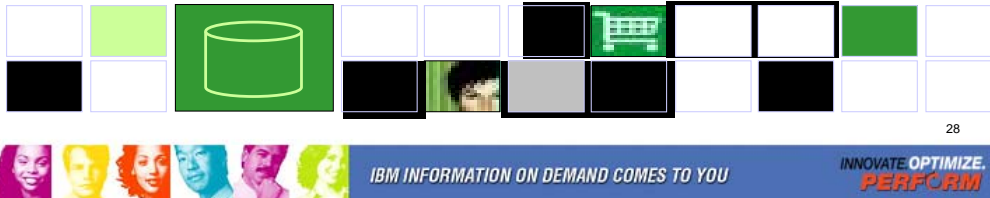
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A tremendous number of enhancements helps application developers to simplify the development process and gain performance improvements when accessing DB2 data. As the DB2 SQL is more consistent with use across the industry, porting an application to DB2 9 for z/OS is much simpler. The learning process is also much faster for those who know only some other DBMS or platform. The additional function delivered in DB2 9 means that applications can use what is provided, rather than delivering this function.

Most consumable DB2 9 improvements

- CM very little to no action:
 - Utility CPU reductions
 - Logging improvements
 - Improved index page split
 - Larger prefetch, write & preformat quantities
 - LOB performance
 - DDF VSCR
 - Optimization Service Center, Opt. Expert, & Data Studio
- Changed online REORG
- Improved RUNSTATS
- Optimization improvements, EDMPOOL VSCR
- NFM
 - LOB lock avoidance
 - Reordered row format
 - Index: larger page sizes, compression, index on expression



Here are some highlights for items that deliver the most quickly and easily:

Very little to no action is required for the utility CPU reductions, logging improvements, improved index page split, larger prefetch, write & preformat quantities, some LOB performance, DDF virtual storage constraint relief. The first group delivers in CM.

The next items require some work. Changed online REORG and other utility improvements require process changes and use of SHRLEVEL(CHANGE).

Improved RUNSTATS statistics needs some analysis to determine where the value is greater than the cost of gathering the new statistics.

Optimization improvements are automatic for dynamic SQL, but require work to REBIND for static SQL. In both cases, we need baselines to check for regression. REOPT(AUTO) for dynamic SQL needs analysis to be sure the improvement is working. EDMPOOL virtual storage constraint relief also requires a REBIND.

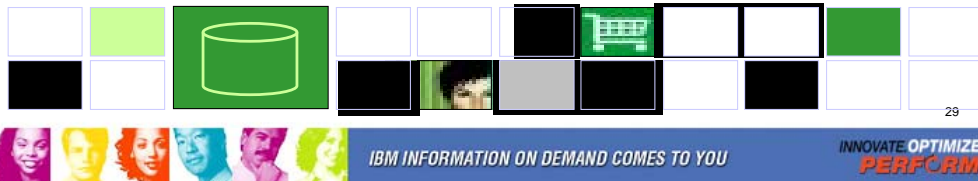
Optimization Service Center takes some learning, but should be fast for those who have used Visual Explain in the past. See the book, SG24-7421, DB2 9 for z/OS: New Tools for Query Optimization.

Reordered row format requires a REORG in NFM and varying length columns.

Index improvements for larger page sizes, compression, index on expression require database design work to determine where they are applicable. ALTERs, REORGs and creation of new indexes are needed.

Migration to DB2 9 for z/OS is easier than V7 to V8

- Migration process enhancements: ENFM shorter, CM*
- Much less performance regression:
 - Earlier improvements
 - Plan stability & tools for avoiding access path issues
- CCSIDs and old product issues resolved in V8
- Simpler virtual storage considerations
- Less impact from incompatible changes
- Earlier deliveries from vendors



DB2 9 migration has been easier for many customers and tends to be faster than DB2 V8. Many customers note that the process and the quality are solid.

Migration process enhancements

ENFM is shorter (10 minutes versus an hour), as only two table spaces need to be reorganized in this phase (versus 18 in V8 including the largest ones).

Drop back to CM* if needed (no single steps without a drop back).

Much less performance regression

More consumable performance improvements

Utility CPU improvements in CM

Plan stability to reduce concern about access path regression.

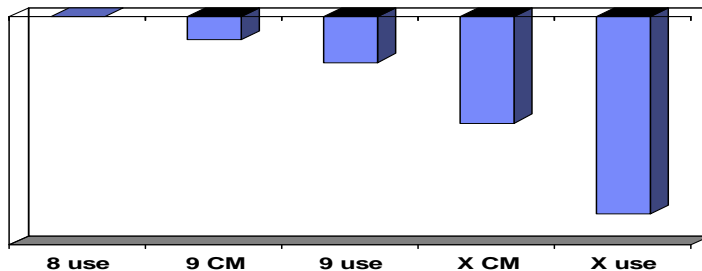
CCSIDs and old product issues resolved in V8 migration, not a problem.

Simpler virtual storage considerations – incremental improvements.

Less impact from incompatible changes

Many vendors are ready today.

DB2 X: performance plan → significant CPU reductions, best with latest processors



Transactions DB design changes
 Batch Hash access
 REBIND application changes
 SQL adjustments

Your situation will vary. Less CPU is better.

Processors z10, z9, z990, z990, and later z/OS 1.10 and later

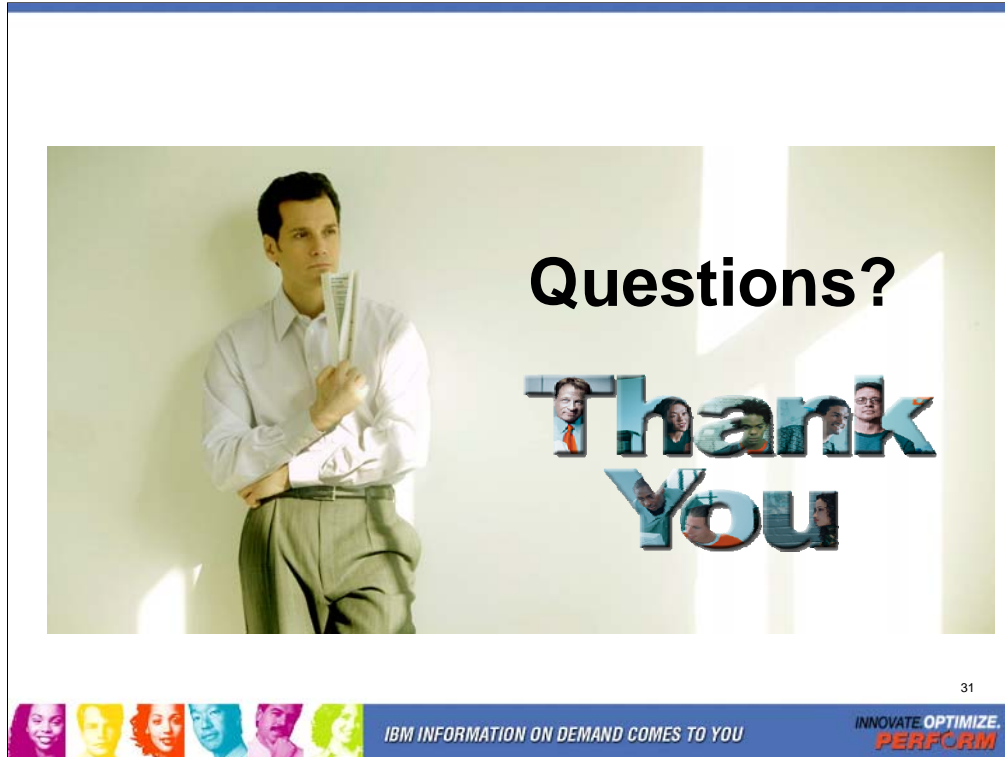


Reducing CPU from DB2 9 to DB2 X without significant administration or application changes is the primary thrust of the performance work. Most of the changes work with CPU caching and path lengths, so that applications are not changed. Packages do not need to be bound. We can take advantage of new instructions without needing to have other techniques for older processors which do not have fast implementations of the new instructions.

This work is very preliminary, but the performance plan for DB2 X is much more aggressive than in any recent version. The last version which contained significant improvements for reducing CPU time in transactions and batch was Version 2 in 1988. Versions 3 to 9 made improvements in queries and in utility CPU time and provided many scalability improvements, but little reduction in transaction CPU time, other than in specific situations.

As customers move from DB2 V8 to DB2 9 CM, they generally find some CPU improvements, often in the utilities. As customers move to DB2 X CM, we anticipate a bigger reduction coming from transactions and batch work. REBIND will improve optimization. The largest improvements are expected for applications that can use the database changes, such as a hash for primary key access, and SQL improvements in DB2 X.

We expect DB2 X to run only on z10, z9, z890, z990, and later processors, and to provide CPU reductions from the beginning, with improvements in CM, but more dramatic reductions for applications that can take advantage of the improvements in application design.



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Thank for attending this session, and thanks in advance for your questions. Some of the early questions focus on migration to DB2 9, security concerns, performance, concurrency, and availability.

For the latest presentations, please see

<ftp://ftp.software.ibm.com/software/data/db2/zos/presentations/>

the next level of directory for these questions are in

migration overview performance security

Here are questions that were sent in ahead of time.

- What would you say about use of multiple brands of databases, pros and cons?
- With the very large DBs resulting from usage of XML, how is IBM addressing image copy and reorg efficiency in the ever narrowing batch windows?
- Do you have advice and pointers for DB2 9 Migration?
- How can I deal with security to keep out hackers?
- Performance is a key concern for me. Where can I learn more?
- DB2 concurrency: My questions are the meaning of the question. Is this concurrency? availability? or what versions are in service?

Answers for early written questions

- What would you say about use of multiple brands of databases, pros and cons? For large customers, the question is one of how many DBMSs, how many instances, and how mixed for business critical applications. Manage carefully. Information integration has improved a lot. Replication and changed data capture mixed with ETL and ELT products has changed the ability, but managing more means more skills and most cost in management.
- With the very large DBs resulting from usage of XML, how is IBM addressing image copy and reorg efficiency in the ever narrowing batch windows? The primary techniques are use of the hardware, such as FlashCopy and making the operations online. FlashCopy can be used to take terabytes of copy in seconds, with no disruption to applications. DB2 9 is excellent for improved availability. See the concurrency and availability pointers below.
- Do you have advice and pointers for DB2 9 Migration?
<ftp://ftp.software.ibm.com/software/data/db2/zos/presentations/migration/>
- How can I deal with security to keep out hackers?
<ftp://ftp.software.ibm.com/software/data/db2/zos/presentations/security/>
- Performance is a key concern for me. Where can I learn more?
<ftp://ftp.software.ibm.com/software/data/db2/zos/presentations/performance/>
- DB2 currency:
 - Concurrency & availability
 - <ftp://ftp.software.ibm.com/software/data/db2/zos/presentations/v9-new-function/availability-betaworks-2007.pdf>
 - <ftp://ftp.software.ibm.com/software/data/db2/zos/presentations/v9-new-function/utilities-db2roadshow-2008.pdf>
 - <ftp://ftp.software.ibm.com/software/data/db2/zos/presentations/v9-new-function/xml-db2-9-zroadshow-2007.pdf>
 - What versions are currently in service or Product support lifecycle <http://www-111.ibm.com/software/support/lifecycle/PLCDetail.wss?psynkey=Z736916P90323T50&synkey=M164003R29014P61&ynkey=O720420C40253K34&from=spf>

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Thank for attending this session, and thanks in advance for your questions. Some of the early questions focus on migration to DB2 9, security concerns, performance, concurrency, and availability. I'll be putting some of my latest presentations on the web this week.

For the latest presentations, please see

<ftp://ftp.software.ibm.com/software/data/db2/zos/presentations/>

the next level of directory for these questions are in

migration

overview

performance

security

DB2 for z/OS Business Value References

IBM

DB2 9 for z/OS Performance Topics

IBM

IBM System z Strengths and Values

triton CONSULTING

DB2 9 for z/OS Data On Demand

Technical presentation of System z hardware and z/OS

Enterprise-wide value for the System z platform

Cost of computing considerations

IBM

The Business Value of DB2 UDB for z/OS

Learn about the synergy of DB2 with IBM's server, z/OS and z/OS

Discover how you can benefit from the richness in function

Be ready for the System z future

Paula Brad, Paul Baker, Dick Baker, John Janssen, John Picking

ibm.com/redbooks

Redbooks

IBM

DB2 9 for z/OS Technical Overview

Read about the new features and functions of DB2 Version 9.1 for z/OS

Understand prerequisites and migration options

IBM

System z10 Mainframe: The Quintessential New Enterprise Data Center

What does "on-demand computing mean" – a system that would enable enterprises to extend the use of information systems – moving beyond the production of report-making, financial, human resources, manufacturing, sales, and distribution reports, and the operation of manufacturing systems – into the flow of new work of major business-critical data processing, operational distribution, user collaboration, and on-demand computing.

In February, 2008, after years of working with customers to build modernized, service-oriented, on-demand computing environments, IBM formally announced new enterprise can build service-oriented data centers. Enabling the new data center model, the "New Enterprise Data Center," IBM described how its customers are using technologies such as virtualization, service-oriented architecture (SOA), automatic provisioning, and business process management software to build data centers capable of supporting tomorrow's interactive, collaborative, Web-based application environments.

As a result of working with IBM's Enterprise Data Center design, IBM announced a major update to its System z10 mainframe (the z10).

From Charles Bradburn's perspective (IBM's CEO), the new z10 EC represents the ideal system design model to service smaller data center design of the future. Due to an internal high-speed bus architecture, the z10 EC can handle 100,000 requests per second (RPS) and 100,000 IOPS. This type of design makes much of the need for external scaling, for external integration and integration protection essential, and for programming, procedure call overhead – as well as an extensive number of external libraries – an external, externalized environment. Further, reducing external network equipment requirements reduces energy consumption, the cost of external hardware, time, and money – and the energy that the firm can use elsewhere.

IBM's System z10, with its innovative processor power and capacity, high-speed internal bus architecture, IBM Service-oriented architecture (SOA) capabilities, energy-efficient hardware, and on-demand computing features, will be the ideal platform upon which to build a service-oriented, new Enterprise Data Center environment.

In the Comments, Charles Bradburn (IBM's CEO), explains why I believe that DB2 for z/OS 9.1 should be your enterprise's "on-demand enterprise choice" when it comes to building a service-oriented, new Enterprise Data Center environment.

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Here are some resources for a discussion of business value in DB2. White papers are useful for a quick summary, and IBM Redbooks publications provide more detailed technical discussion.

ftp://ftp.software.ibm.com/software/data/pubs/papers/DB2_for_zOS_V9_Business_Value_White_Paper.pdf

http://www.ibm.com/software/os/systemz/newsletter/mainstreamed11_uk.html

The Business Value of DB2 for z/OS, SG24-6763,
<http://www.redbooks.ibm.com/abstracts/sg246763.html>

DB2 9 for z/OS Technical Overview, SG24-7330, chapter 2 on System z synergy,
<http://www.redbooks.ibm.com/abstracts/sg247330.html>

DB2 9 for z/OS Performance Topics, SG24-7473, performance on z10,
<http://www.redbooks.ibm.com/abstracts/sg247473.html>

What DB2 Means to Business Value, Talk DB2 in business terms the suits can understand.
<http://www.ibmdatacom.com/story/showArticle.jhtml?articleID=199201819>

System z Strengths and Values, SG24-7333,
<http://www.redbooks.ibm.com/abstracts/sg247333.html>

http://www.idug.org/wps/portal/idug/kcxml/04_Sj9SPykssy0xPLMnMz0vM0Y_QjzKLN4o38rAESYGYnoH6kehCAQghX4_83FT9IKBUpDIQyMzDRz8qJzU9MbISP1jfWz9AvyA3NKLC29ERAP8BqUk!/delta/base64xml/L0IJSk03dWIDU1EhIS9JRGpBQU15QUJFUkVSRUlnLzRGR2dkWW5LSjBGUm9YZmcvN18yXzZITA!!?PC_7_2_6HL_WCM_CONTEXT=/wps/wcm/connect/IDUG+Site/Solutions+Journal/Solutions+Journal+Online+Magazine/Volume+15%2C+Number+2/IDUG-SolutionsJournalArticle-Content-Developer-s+Corner%3A+Time+to+Plan+for+Migration+Again

DB2 9 in IBM Redbooks Publications

1. DB2 9 Technical Overview SG24-7330
2. DB2 9 Performance Topics SG24-7473
3. DB2 9 Stored Procedures SG24-7604
4. Index Compression with DB2 9 for z/OS redp4345
5. SQL Reference for Cross-Platform Development
6. Enterprise Database Warehouse, SG24-7637
7. 50 TB Data Warehouse on System z, SG24-7674
8. DB2 9 Optimization Service Center SG24-7421
9. LOBs with DB2 for z/OS SG24-7270
10. Deploying SOA Solutions SG24-7663
11. Enhancing SAP - DB2 9 SG24-7239
12. SAP Application on Linux z SG24-6847
13. Best practices SAP BI - DB2 9 SG24-6489-01
14. Data Sharing in a Nutshell, SG24-7322
15. Securing DB2 & MLS z/OS SG24-6480-01
16. Data Sharing: Distributed Load Balancing & Fault Tolerant Configuration redp4449
17. Considerations on Small & Large Packages redp4424
18. Backup and Recovery Considerations redp4452
19. Powering SOA with IBM Data Servers SG24-7259
20. Packages Revisited, SG24-7688
21. Data Studio V2.1 Web Services redp4510



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DB2 library more information <http://www.ibm.com/software/data/db2/zos/library.html>

Many IBM Redbooks publications, Redpapers and one cross-platform book on DB2 9 are published, in addition to the standard library, with more in the works. Check for updates.

1. DB2 9 Technical Overview, SG24-7330 <http://www.redbooks.ibm.com/abstracts/SG247330.html>
2. DB2 9 Performance Topics, SG24-7473, <http://www.redbooks.ibm.com/abstracts/SG247473.html>
3. DB2 9 Stored Procedures, SG24-7604, <http://www.redbooks.ibm.com/abstracts/SG247604.html>
4. Index Compression DB2 9, REDP4345, <http://www.redbooks.ibm.com/abstracts/redp4345.html>
5. Deploying SOA Solutions SG24-7663, <http://www.redbooks.ibm.com/abstracts/SG247259.html>
6. Cross-Platform Development Version 3, <http://www.ibm.com/developerworks/db2/library/techarticle/0206sqlref/0206sqlref.html>
ftp://ftp.software.ibm.com/ps/products/db2/info/xplatsql/pdf/en_US/cpsqlrv3.pdf
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