Introduction to IBM® Cognos® 8 BI for Linux® on System z®

Deploying and Scaling IBM Cognos 8 BI for Linux on System z

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Highlights

IBM® Cognos® 8 Business Intelligence for Linux® on System z® brings industry leading Business Intelligence (BI) functionality to System z.

- System z virtualization (z/VM) provides a dynamically managed platform environment within which to run IBM Cognos 8 BI
- IBM Cognos 8 BI leverages the reliability, availability and scalability characteristics of the System z platform
- System z provides customers the ability to leverage existing processors, processes and people for an Enterprise BI solution without introducing requirements for new technology and skills.
- New workloads may be added in order to accommodate new BI applications or the expanding requirements of existing applications without significant increases in electrical power requirements.
- Customers using Cognos for Linux on System z avoid the under-utilization of system resources typical of distributed server deployments.

IBM Cognos 8 BI v8.4 provides many options for the deployment of a high performance platform that can scale to meet the largest demands of BI applications. Additionally, the performance, flexibility, and inherent stability of Linux on IBM System z provide an ideal platform to support the processing demands of large scale IBM Cognos 8 BI applications.

IBM Cognos 8 BI can be deployed on System z using a single or multiple LPARs running Linux either native or as a guest within z/VM.

This document provides an overview of best practice configurations for IBM Cognos 8 BI v8.4 on Linux for System z and refers to testing and content generated to support chapter 13 of the Redbook – "*Enterprise Data Warehousing with DB2 9 for z/OS"* which can be found here - http://www.redbooks.ibm.com/abstracts/sg247637.html?Open

Overview of IBM Cognos 8 BI

IBM Cognos 8 BI for Linux on System z delivers a broad range of BI capabilities on an open, enterprise-class platform. All capabilities, including viewing, creating and administering reports, analysis, scorecards, dashboards and events are accessed through the web.

The IBM Cognos 8 Platform delivers the right capabilities to manage the solution with centralized and web-based administration that provides a complete view of system activity as well as system metrics and thresholds to be able to resolve potential issues before business impact. The IBM Cognos 8 Platform is built on web-based service oriented architecture (SOA), designed for scalability, availability and openness. This n-tiered (SOA) has three tiers: Web, application and data. The tiers are based on business function, and are typically separated by network firewalls.

When the platform was designed and built - reliability and scalability were key considerations. Services in the application tier operate on a peer to peer basis. That means in effect that no service is more important – there is no "master" service. Any service of the same type, on any machine in an IBM Cognos 8 Platform configuration, is capable of servicing an incoming request. The result? Complete fault tolerance – any request can be routed to and handled by any server in the system. The dispatching of requests is done in an optimal way – with automatic load balancing built into the system.

The IBM Cognos 8 Platform provides optimized access to all data sources, including relational data sources and online analytical processing (OLAP), with a single query service. In addition this query service understands and leverages the data source strength by using a combination of open standards such as SQL99, native SQL and native MDX to optimize data retrieval for all these different data providers. The IBM Cognos 8 BI user interfaces are accessed via Web tier, as shown in Figure 1.

IBM Cognos 8 Platform Architecture

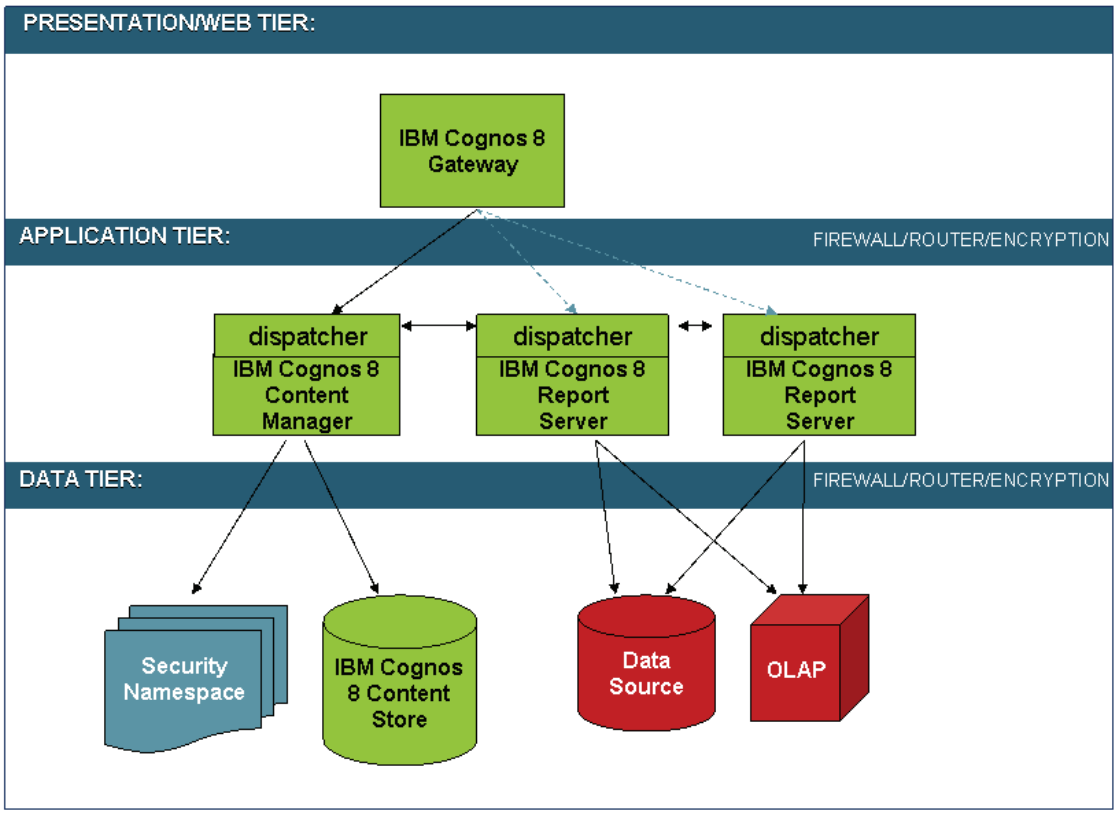


Figure 1. Typical IBM Cognos 8 BI distributed server deployment

Web Tier

IBM Cognos 8 Gateway

The IBM Cognos 8 Gateway component manages all Web communication for the IBM Cognos 8 Platform. The workload on the IBM Cognos 8 Gateway server is comparatively lightweight, therefore, it requires minimal processing resources. For high availability or scalability requirements, you can deploy multiple redundant gateways along with an external HTTP load-balancing router

Application Tier

The application tier for the IBM Cognos 8 Platform is made up of three main server components; the IBM Cognos 8 Content Manager, Dispatchers, and Report Servers; which may execute within WebSphere Application Server. Report Servers are composed of a collection of Java and C++ services.

IBM Cognos 8 Dispatcher

IBM Cognos 8 Dispatcher performs the load balancing of requests at the application tier. The Dispatcher component is a lightweight Java™ servlet that manages (and provides communication between) application services. At startup, each IBM Cognos 8 Dispatcher registers locally available services with the IBM Cognos 8 Content Manager. During the normal operation of IBM Cognos 8 BI services, requests are load balanced across all available services by using a configurable, weighted round-robin algorithm to distribute requests. You can tune the performance of IBM Cognos 8 Platform by defining how Dispatcher handles requests and manages services. A normal configuration for Dispatcher is two Report Server (see IBM Cognos 8 Report Server) processes per allocated processor, and 8 to10 threads per process (either 3 low plus 1 high affinity threads or 4 low plus 1 high per process). Threads within IBM Cognos 8 Platform are managed by the type of traffic that they handle -- referred to as *high* and *low affinity* – where affinity relates to the report service process which handled the original user request when multiple interactions need to occur to satisfy the request. High-affinity connections are used to process absolute and high-affinity requests from the report services, whereas low-affinity connections are used to process low-affinity requests. A high affinity request is a transaction that can benefit from a previously processed request. It can be processed on any service, but resource consumption is minimized if the request is routed back to the report service process that was used to execute the original process. A low affinity request will operate just as efficiently on any service.You can manage the number of threads per IBM Cognos 8 BI reporting service process through the IBM Cognos 8 Platform Administration Console by setting the number of high- and low-affinity connections. For more details, refer to the *IBM Cognos 8 BI Architecture and Deployment Guide* (http://support.cognos.com, navigate to the Documentation page and select the **IBM Cognos 8 Business Intelligence 8.4** product).

IBM Cognos 8 Report Server

The main service that is responsible for application-tier processing is the report or query service (often referred to as the BIBus processes). The Dispatcher starts Report Server processes dynamically as needed to handle the request load. An administrator can specify the maximum number of processes that these services can start as well as the minimum that should be running at non-peak times. You should configure the number of processes for a Report Server based on the available processor capacity. In general, the IBM Cognos 8 BI reporting service performance is closely tied processor clock speed and throughput capabilities. The number of processors in a server and their clock rates are the two primary factors to consider when planning for additional Report Server hardware capacity. For example, you generally configure a server with four available processors to use more report- service processes than a server with only two available processors. Similarly, given two servers with an equal number of processors, you should configure the server with a significantly faster processor clock rate to have more report and report-service processes.

When configuring the IBM Cognos 8 Platform server environment, you have to set a Java heap size. The IBM Cognos 8 BI reporting and query service is made up of two

underlying components — the Java servlet-based Dispatcher services and report services that are launched using the Java Native Interface (JNI). Set the Java virtual machine (JVM) heap-size allocation for IBM Cognos 8 Platform so that Java memory is only as large as is necessary to accommodate the processing requirements of the Java based services. This ensures that as much memory as possible is available to the IBM Cognos 8 BI reporting service which are not Java. Optimal Java heap size can be determined though use of Java garbage collection statistics.

IBM Cognos 8 Content Manager

Content Manager is the IBM Cognos 8 Platform service that manages the storage of customer application data, including security, configuration data, models, metrics, report specifications and report output. Content Manager is needed to publish models, retrieve or store report specifications, handle scheduling information and manage the Cognos name space. Content Manager maintains information in a relational database that is referred to as the content-store database. A minimum of one Content Manager service is required for each IBM Cognos 8 Platform implementation. Content Manager performance can benefit from the availability of high-speed RAM resources and typically requires one processor for every four processors allocated for Report Server processing.

IBM Cognos 8 BI data-source performance

Query performance is typically bound to the performance of the server that hosts the data source for IBM Cognos 8 BI, which can access many data sources including relational and OLAP sources. Relational data sources that are tuned to meet the access requirements of the business community naturally perform better than those that are not. Relational database-management systems (RDBMSs) should be monitored and tuned by an experienced database administrator to achieve optimum database performance.

IBM Cognos 8 BI Deployment Options

The first step to creating a proper IBM Cognos 8 BI environment begins with a successful installation. Use the *IBM Cognos 8 BI Installation and Configuration Guide* to lead you through the installation and initial configuration process. For detailed information about IBM Cognos 8 Platform architecture and server deployment options, read the *IBM Cognos 8 BI Architecture and Deployment Guide*.

Server components within all three tiers can easily scale either horizontally or vertically to meet a variety of very large BI processing requirements. At the Web tier, the IBM Cognos 8 Gateway system requirements are lightweight and can therefore handle large user loads with fewer system resources than other server tiers in the IBM Cognos 8 Platform architecture. You can also deploy multiple Gateway instances to meet requirements for additional user load, server availability or other service-level agreements (SLA's).

At the application tier, both the IBM Cognos 8 Report Server and Content Manager components can scale to meet application-processing requirements. You can deploy

multiple Content Manager instances; one Content Manager instance will actively process requests while the other instances will remain in standby mode to provide high availability. Content Manager Server hardware can also scale vertically to provide increased throughput. IBM Cognos 8 Report Server performs the heavy lifting within an IBM Cognos 8 BI server deployment. You can deploy multiple Report Server instances to meet the processing requirements of very large applications and user populations. Report Server performance is tied to overall system performance and, therefore, can be affected by processor clock speed and I/O performance.

General Recommendations

In general, decisions regarding the best methods for deploying IBM Cognos 8 BI for Linux on System z are driven by the same application characteristics as any other platform – user concurrency, application complexity, and systems management requirements. However, System z architecture and performance features provide superior throughput potential and the ability to more effectively utilize all available system resources through use of the z/VM Hypervisor and one or more of the below Linux guest configurations:

- One Linux guest with multiple IBM Cognos 8 Platform instances, the IBM Cognos 8 Report Servers and IBM Cognos 8 Content Manager, implemented in one or more WAS profiles or JVM's
- One Linux guest per IBM Cognos 8 Platform application tier server instance
- Separate LPAR or Linux guest for DB2 (Content Store and/or datasources)
- Over-subscription of CPU (CP) resources, the total number of CPs allocated amongst the z/VM virtual guest servers for the IBM Cognos 8 Platform may exceed the number of physical CPUs allocated to the z/VM LPAR.
- 1.3 to 1.7 GB RAM per CPU on Content Manager and Report Server instances
- Report Servers with two BIBus processes per CP and five threads per process (4 low and 1 high affinity)
- A minimum of 2 virtual CPs in the Linux guest for the Report Server and/or Content Manager

IBM Cognos 8 BI Deployment Options on System z

IBM Cognos 8 Platform deployments on System z can still be thought of in the same way as typical deployments for distributed server platforms. All IBM Cognos 8 BI tiers may reside on one or more System z systems. The various server roles within the IBM Cognos 8 Platform architecture may be either deployed within a single Linux instance or distributed across multiple instances of Linux. Normal IBM Cognos 8 BI scalability configurations still apply. The difference is that Linux instances will be deployed within native LPARs or as guests within z/VM, or as a combination of both native Linux LPARs and z/VM Linux guests. Either Linux LPARs or z/VM Linux guests can be viewed as an equivalent to a distributed server instance for IBM Cognos 8 Platform deployment planning purposes.

Native Linux LPAR Deployments

While native Linux LPAR based deployments of IBM Cognos 8 BI may provide marginally superior performance, native LPAR configurations provide a reduced level of flexibility and make less efficient use of overall System z resources. Native Linux LPARs are statically assigned processor resources – either dedicated or shared. Changes to LPAR configurations require an IPL/re-boot before they take effect. IBM Cognos 8 BI servers may be deployed either within a single Linux LPAR or distributed across multiple LPARs.

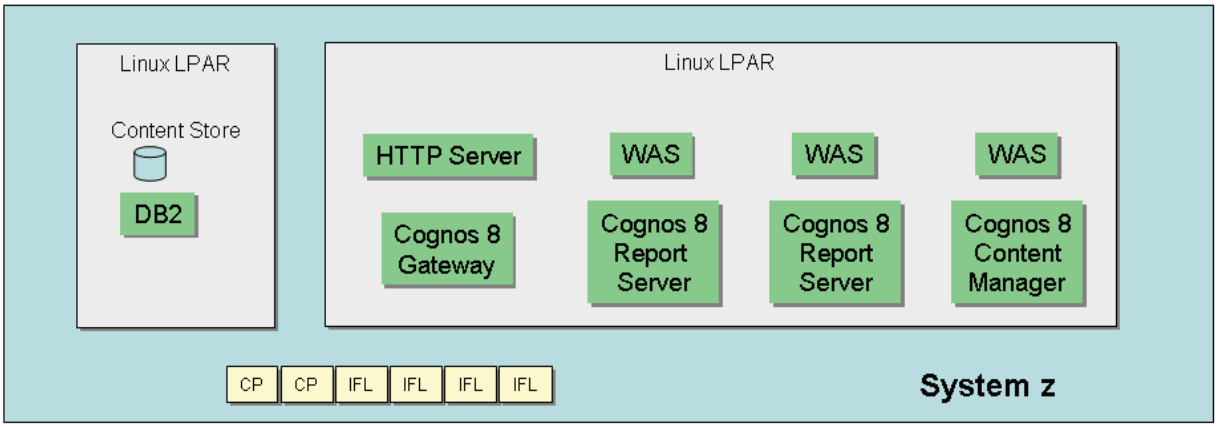


Figure 2. Typical IBM Cognos 8 BI server deployment using Linux LPARs on IBM System z

Linux Guest Deployments on z/VM

The use of guests within z/VM is the preferred approach to deploying Linux based applications such as IBM Cognos 8 BI. There may be a performance cost associated with using the z/VM hypervisor versus implementing with native Linux LPARs. However, the deployment of multiple Linux guests along with the oversubscription of processor resources may also result in more effective utilization of system resources and improved overall application throughput (see Scenario 2 below). Additionally, the virtual network provided by z/VM for the inter-guest communication may provide the advantage of high throughputs at low network latency and may reduce the investment and maintenance of physical hardware such as switches, routers, and cables. z/VM also provides the flexibility to easily deploy new instances of IBM Cognos 8 BI servers in order to quickly scale out the capacity for the application during peak load or to accommodate new application requirements.

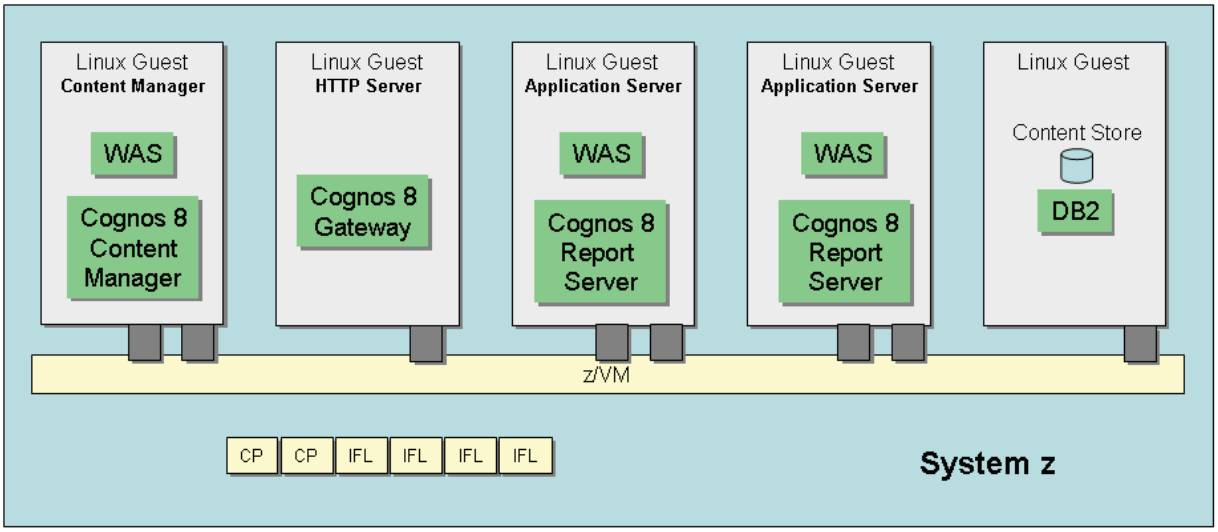


Figure 3. Typical IBM Cognos 8 BI server deployment using z/VM & multiple Linux guests

IBM Cognos 8 BI Performance Considerations

Several factors influence IBM Cognos 8 BI performance independent of server platform:

- IBM Cognos 8 Report Server performance is greatly tied to processor clock speed
- IBM Cognos 8 Content Manager performance and scalability is dependent upon available memory and the size of content store. The size of a content store can be impacted by the amount of pre-generated, saved reports, and the number of retained report versions. Managing content store size helps in maintaining overall IBM Cognos 8 BI application performance and scalability.
- Data source performance plus report and query design and complexity, including the impact of local report server query processing, will determine the overall performance of any BI application
- Burst and batch reporting can be used to defer the processing of pre-defined reports to times of lower overall system load.
- Overall I/O performance, or I/O bottlenecks, can impact application performance and scalability, and should be addressed before increasing CPU resources. The performance of reports requiring local processing can be greatly impacted by disk I/O performance.

Native LPAR and z/VM Base Test Results

Tests confirm that IBM Cognos 8 BI deployments using native Linux LPAR and z/VM configurations provide similar performance and scalability characteristics. While use of LPARs to host native deployments of Linux does provide a slight performance edge, LPAR based deployments lack the flexibility and administrative benefits of z/VM hosted Linux guests. The following measurements were done on an IBM z10 with a cluster of up to seven Linux servers running IBM Cognos 8 BI (up to two IBM Cognos 8

Gateways, up to three IBM Cognos 8 Report Servers, one IBM Cognos 8 Content Manager, and one DB2 LUW server with IBM Cognos 8 Content Store) and one z/OS DB2 LPAR containing the test data sources. The total number of CPs available to all the IBM Cognos 8 BI servers was 14; each server had 2 CPs defined to it. These Linux servers executed either as all native Linux LPARs or as all guest servers in a single z/VM LPAR. The z/VM LPAR had up to 14 total virtual CPs allocated to IBM Cognos 8 BI processing. The z/OS DB2 LPAR had 2 CPs assigned.

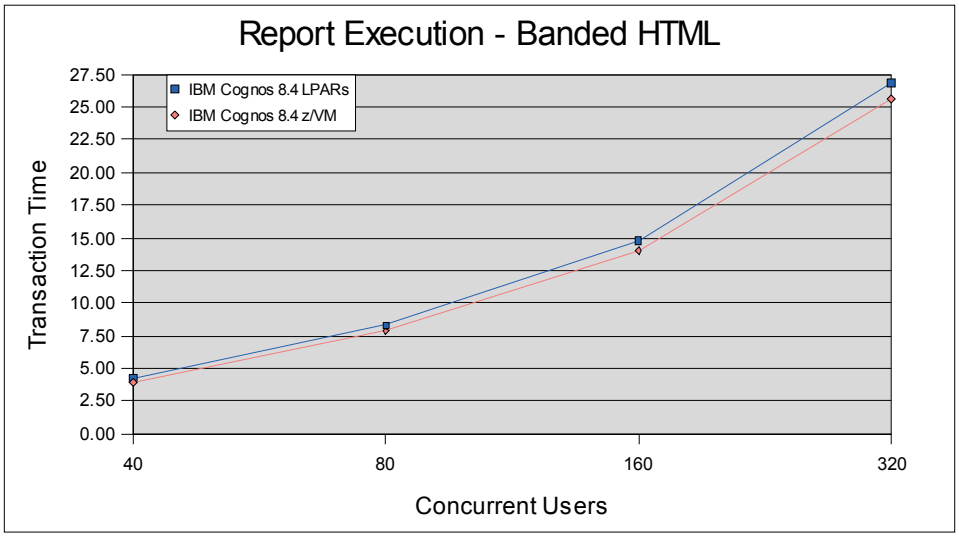


Chart 1. Comparison of LPAR and z/VM performance for banded HTML reports

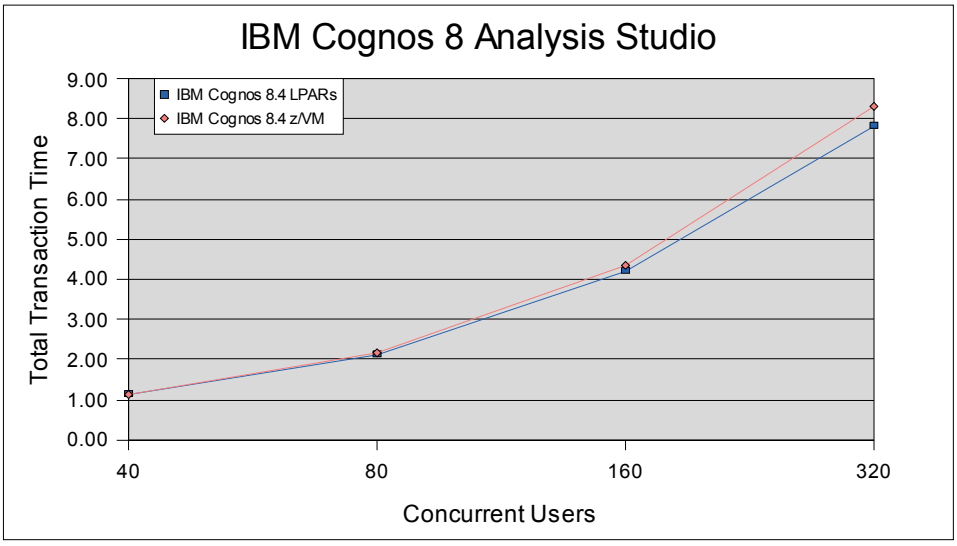


Chart 2. Comparison of LPAR and z/VM performance Analysis Activity

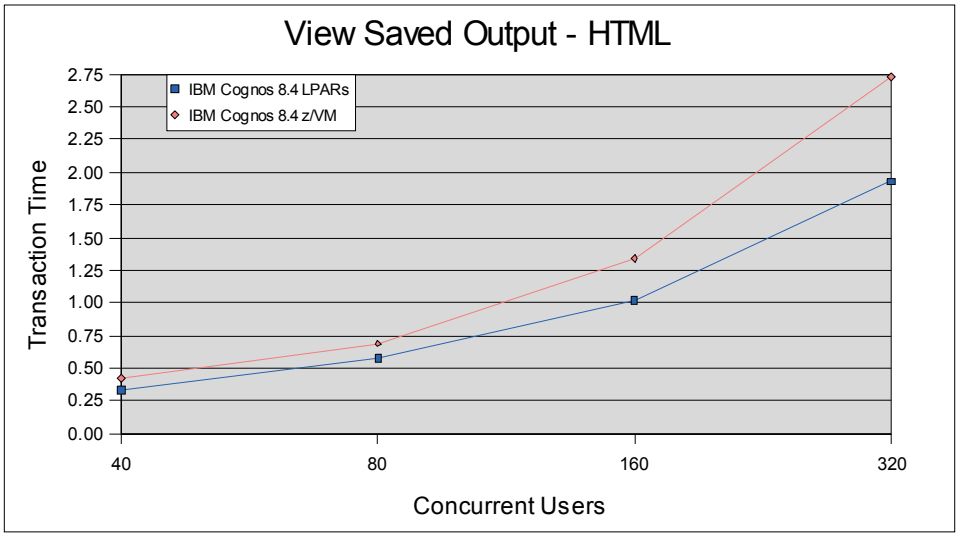


Chart 3. Comparison of LPAR and z/VM performance for viewing saved reports

IBM Cognos 8 BI "Very Large Database" (VLDB) Tests

This study concentrated on IBM Cognos 8 BI accessing a 10 TB z/OS data source including a 7 TB fact table. Multiple workloads were defined and load tested with various z/VM guest deployment options and at multiple user concurrency levels. Zero think time occurred between navigation steps, receipt of report, and submission of another report request. The Cognos guest server(s) were allocated the equivalent of 8 - z10 CPUs, and the z/OS DB2 LPAR also had 8-z10 CPUs available to it for the below results.

The workloads used in these tests included:

- An operational reporting (OpBI) transaction, Figure 4, composed of four Cognos reports accessing a fact table with dimension joins needing only small amounts of data that were optimized with index access. This test case simulates the day to day use of IBM Cognos 8 BI to provide information to a broad base of users related to business operations – such as Sales, Accounting, or Inventory Management – against a structured data source. This test case demonstrates to power and flexibility of the IBM Cognos 8 BI server architecture in delivery of information to a large user base. Note the use of graphs and charts to facilitate quick analysis of the customer buying patterns and value.

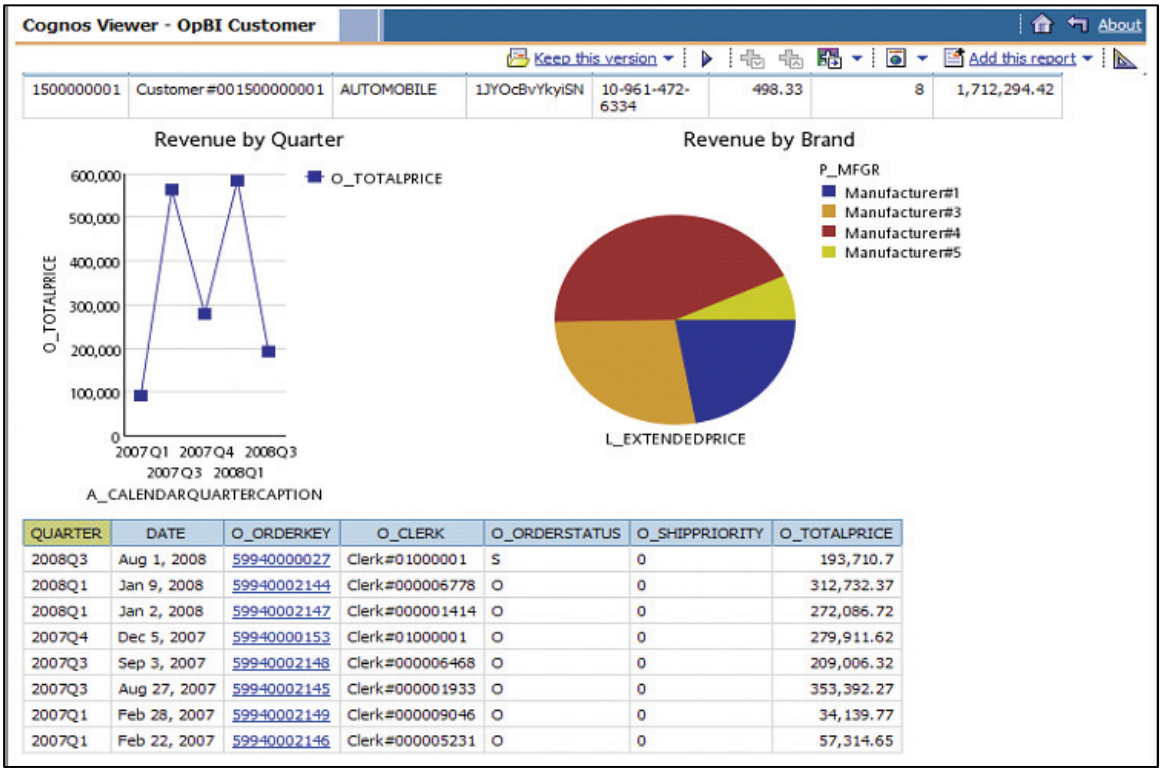


Figure 4. Sample "operational BI" report used for VLDB testing

- A pre-generated, saved report transaction (SavedRep), Figure 5, simulating an application used to deliver high volume reports to report consumers – such as the order below with an inventory shortage and suggested alternative suppliers for follow-up action or billing and account statement reports used in retail and telecommunications industries. This reporting transaction only utilized resources on the IBM Cognos 8 BI servers and basic queries to the IBM Cognos 8 Content Store. No activity to the original data source occurs.

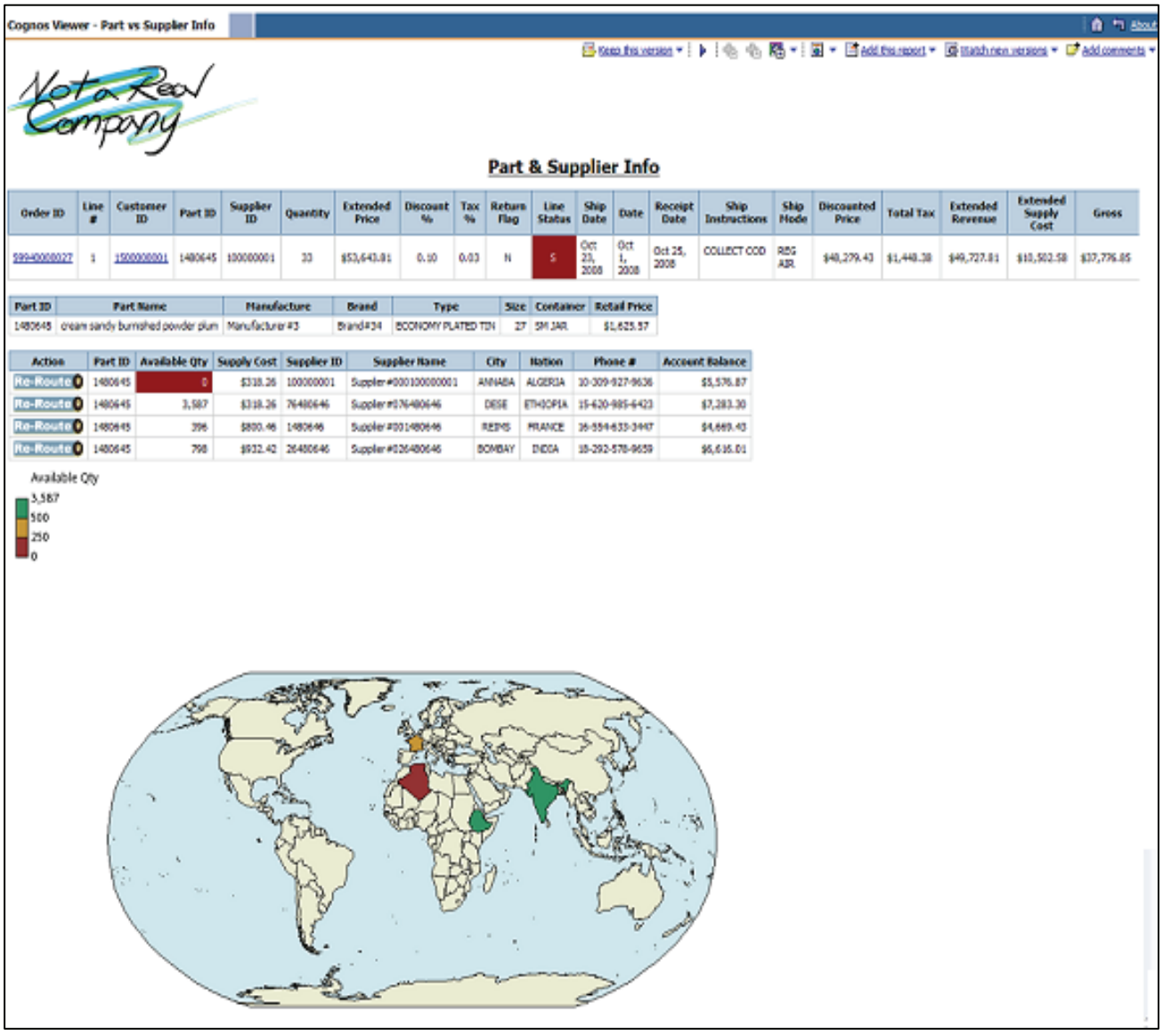
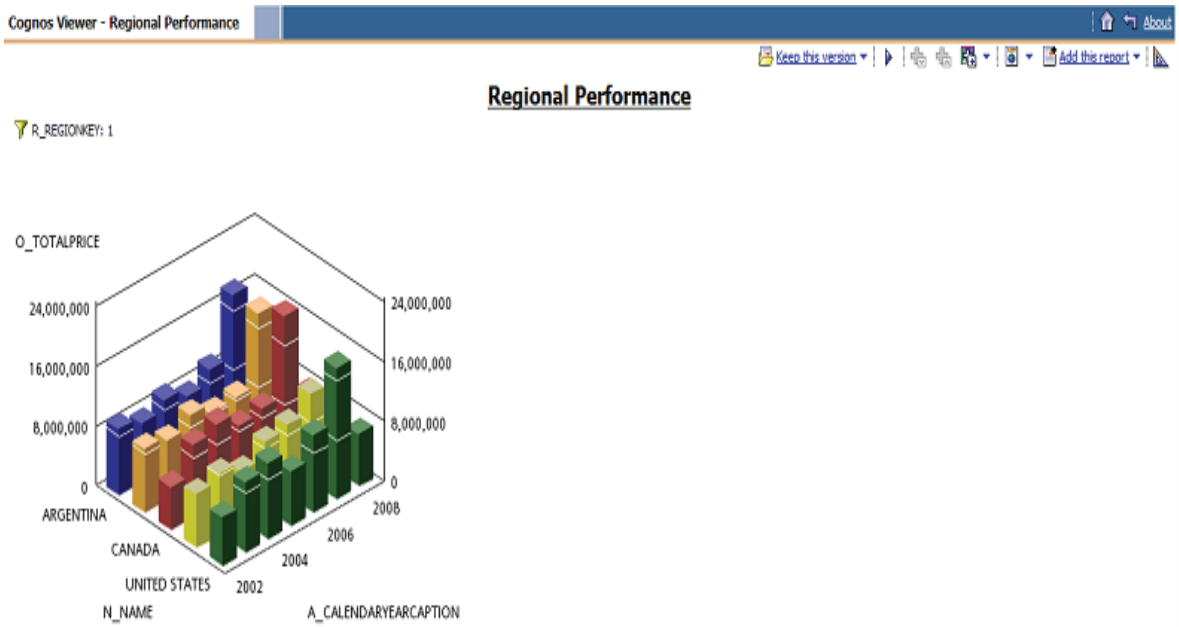


Figure 5. Sample saved report used for VLDB testing

- A complex database transaction (ComplexBI), Figure 6. Access to the z/OS DB2 data source is long running and the SQL query consumes many CPU resources at the z/OS database server to return an answer to the IBM Cognos 8 BI application tier. This test case demonstrates the ability of IBM Cognos 8 BI to provide high performance BI application platform even within environments where data sources are not optimized for reporting. This test case also provides load for System z outside of the z/VM and Linux for System z guests – further demonstrating the ability of System z to handle differing workloads for BI applications.



O_TOTALPRICE	2002	2003	2004	2005	2006	2007	2008
ARGENTINA	8,903,234.52	7,865,636.13	9,261,800.28	7,974,006	9,829,223.82	18,085,415.46	9,253,722.44
BRAZIL	8,641,797.5	7,988,007.71	9,611,839.88	8,165,500.15	8,464,643.68	17,982,437.04	9,911,745.28
CANADA	5,853,351.63	9,718,616.01	10,763,358.4	8,763,704.71	9,276,182.17	19,912,845.16	7,621,027.42
PERU	7,187,485	8,151,364.97	6,698,209.7	8,907,036.06	9,406,884.87	11,771,766.12	8,362,814.64
UNITED STATES	6,453,242.64	9,369,248.47	10,245,887.71	7,351,463.72	10,351,386.81	17,645,357.82	7,032,636.14

Figure 6. Sample report causing a long-running SQL query used for VLDB testing

Each workload was measured individually with various system configurations, IBM Cognos 8 BI JVM deployment options, and at difference concurrent user levels. Also, mixed workloads with all three types of transactions were measured:

- Mix 60/30/10 - 60% OpBI, 30% SavedRep and 10% ComplexBI
- Mix 30/60/10 - 30% OpBI, 60% SavedRep and 10% ComplexBI

These applications and test scenarios were chosen due to their differing load behavior on the IBM Cognos 8 BI server stack and are not intended to be representative of all business applications. A customer's IBM Cognos 8 BI application and the system utilization of real world applications may vary from the results list below. These tests were chosen to demonstrate the behavior of IBM Cognos 8 BI on Linux for System z and cannot be used to for system resource sizing or capacity planning purposes.

For assistance with capacity planning for IBM Cognos 8 BI application please contact your IBM Cognos Software representative.

Scenario 1: The application types and their effect upon server utilization

This is measured with a cluster of five z/VM Linux guest servers running IBM Cognos 8 BI servers (1 IBM Cognos 8 Gateway, 2 IBM Cognos 8 Report Servers, 1 IBM Cognos 8 Content Manager, and 1 DB2 server with IBM Cognos 8 Content Store) and one z/OS DB2 LPAR containing the test data sources. The total number of virtual CPs across all the IBM Cognos 8 BI guests is eight.

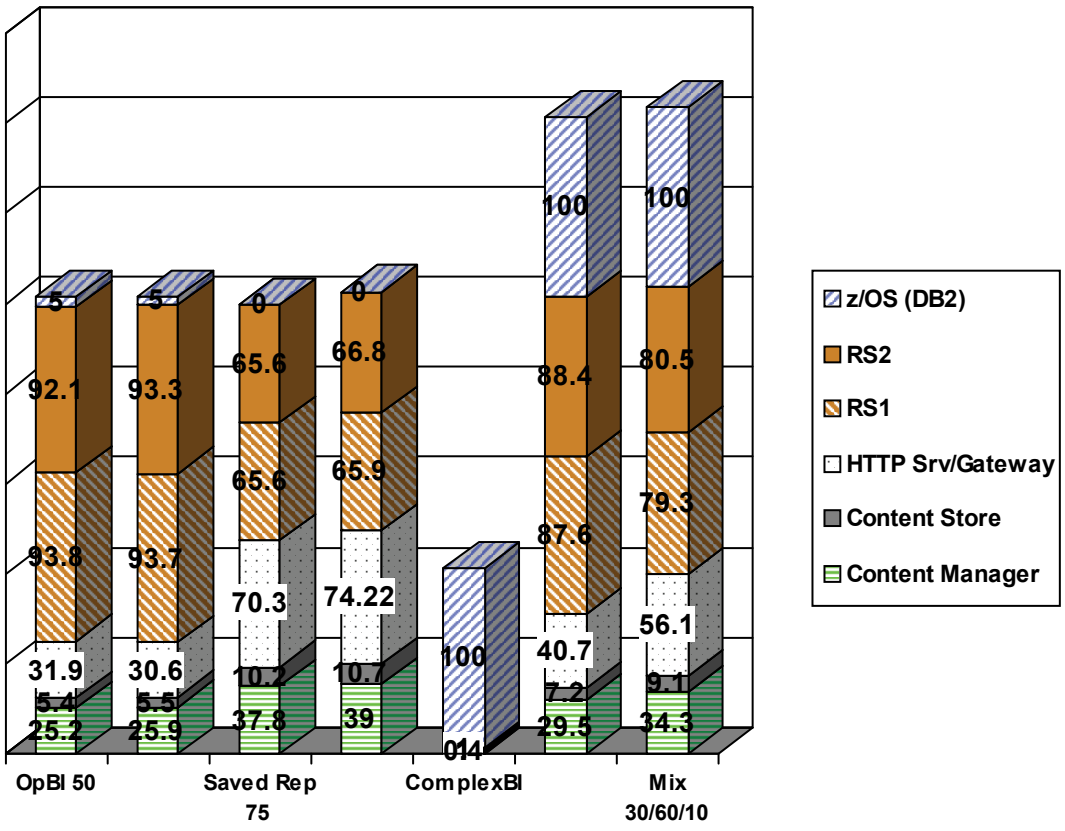


Chart 4. Cognos component CPU utilization

- With the OpBI transaction, the z/OS DB2 LPAR uses very low CPU resources. Also, the IBM Cognos 8 Report Servers are the most heavily utilized of all servers in this workload.
- Note the relative low DB2 content store CPU utilization for all the above workloads.
- In the SavedRep scenario, the IBM Cognos 8 Content Manager and HTTP server CPUs are more utilized since requests for the pre-computed reports are short running without any data source access and the web client request/receive rate is much higher with the zero think time scenario used in these tests. The IBM Cognos 8 Report Server CPU utilization continues to be high as the presentation/rendering processing is handled by the Presentation service which must be co-located with a Report Server.
- In the ComplexBI scenario, little IBM Cognos 8 BI processor resources are utilized as expected. The Report Servers in this test must wait for the DB2 query processing to complete before reports are generated and prepared for the user.
- In the mixed workload scenario in which all three application types are run concurrently, the Linux z/VM guests hosting the IBM Cognos 8 BI servers display varying CPU utilization rates, signaling that unused processor capacity likely exists in most traditional distributed server configurations.

Scenario 2: Over-subscription/over-commitment of processor resources with z/VM virtualization

With z/VM virtualization, CPU resources may be over-subscribed/over-committed amongst the guests, i.e., the total number of virtual CPUs defined to the guests may exceed the total number of real CPUs actually available to the z/VM LPAR. This enables automated, dynamic dispatching of CPU resources from less active guests to busy guests and may improve total throughput. To test this, the number of servers is the same as Scenario 1, but the total number of virtual CPs is 11, an over-commit ratio of 11 to 8 or almost 1.4. As the HTTP and Report Servers' had the higher average CPU utilization for most workloads, as much as 90%+ in the OpBI transaction, their virtual CPs definitions were increased by 1 each.

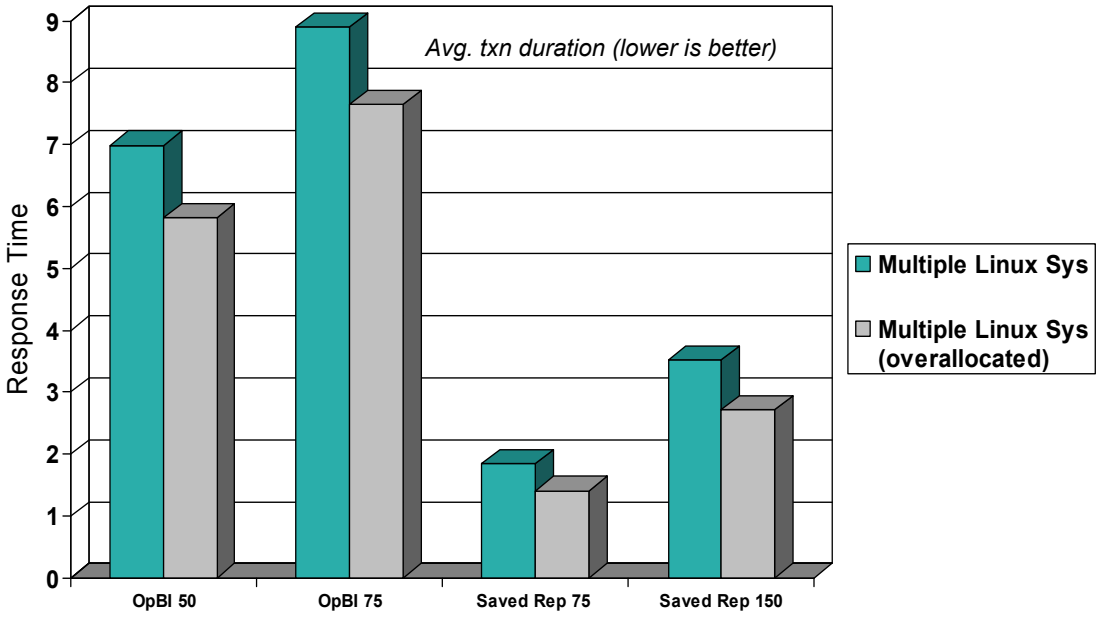


Chart 5; z/VM Cognos Over-commit -- Response Time

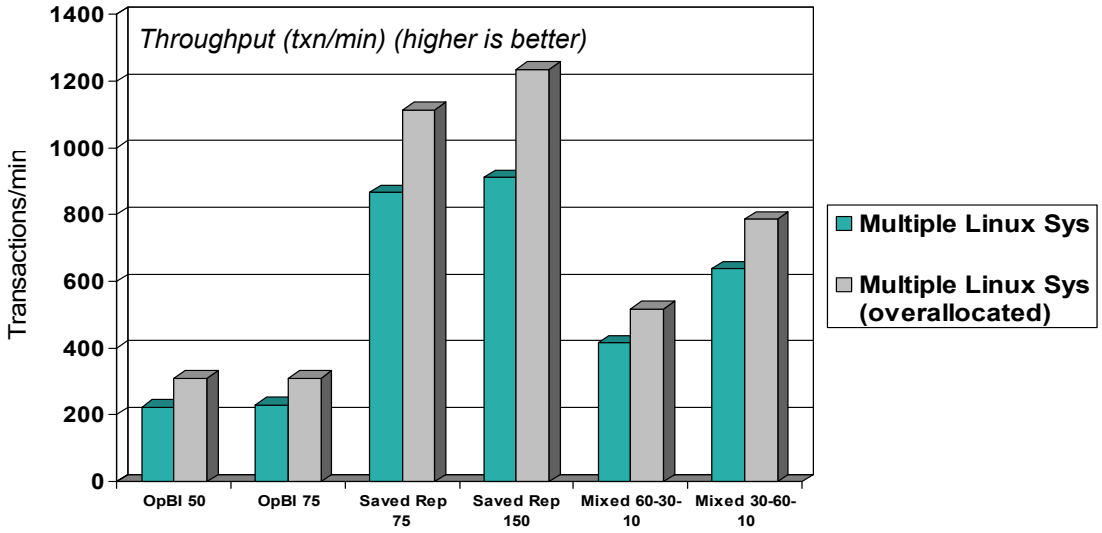


Chart 6. z/VM Cognos Over-commit -- Transaction Throughput

- Over-commitment of CPU resources lowered transaction response times and enabled higher throughput because excess total CPU capacity existed amongst the Cognos servers.

- The IBM Cognos 8 Content Manager and content store servers were not fully utilized as seen in Chart 4. Cognos component CPU utilization. z/VM managed the unused capacity by dynamically allocating it to the IBM Cognos 8 Report Servers and HTTP server on a demand basis. However, if the IBM Cognos 8 Content Manager or the content store needed processor resource, z/VM dynamically allocated the CPU to it as in the prior configuration since the virtual configuration for them had not changed.

Scenario 3: IBM Cognos 8 BI deployment options

The traditional IBM Cognos 8 BI deployment is with multiple distributed servers to handle concurrent user workloads. Linux for System z as a full 64 Bit operating system allows more than 2 GB addressable memory and therefore can easily host more than one WebSphere Application Server profiles with its associated JVM, even though the JVMs are running in 31 Bit mode.

These deployments under z/VM were measured:

- a single Linux guest with all IBM Cognos 8 BI server components, a single JVM, and limited to 8 virtual CPs

- a single Linux guest with all IBM Cognos 8 BI server components, but three JVMs: one each for the IBM Cognos 8 Content Manager and two IBM Cognos 8 Report Servers, and limited to 8 virtual CPs

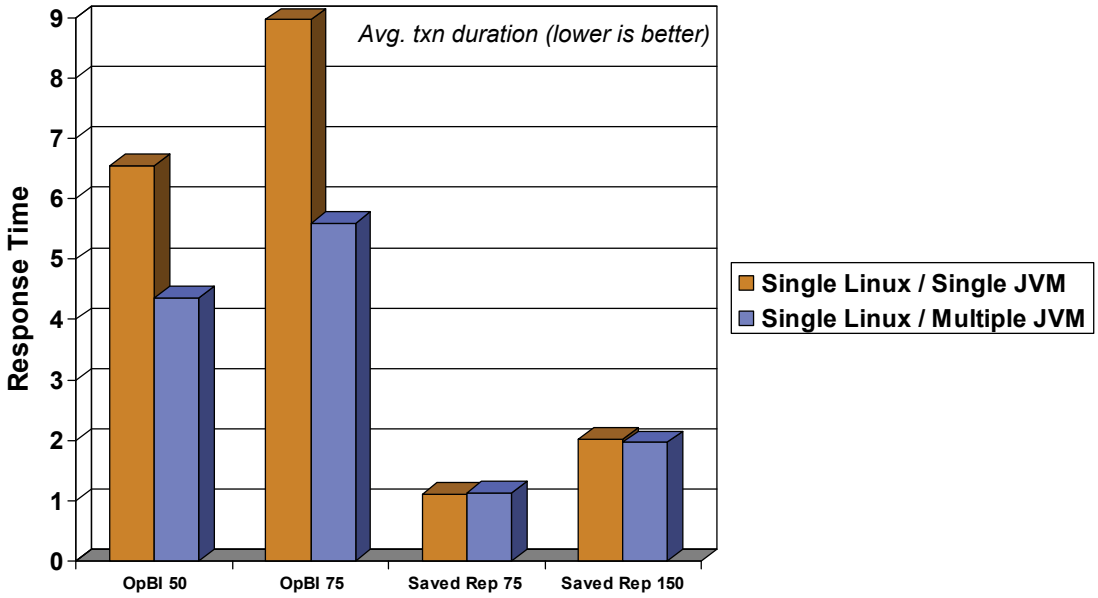


Chart 7. z/VM JVM IBM Cognos 8 BI deployments -- response time

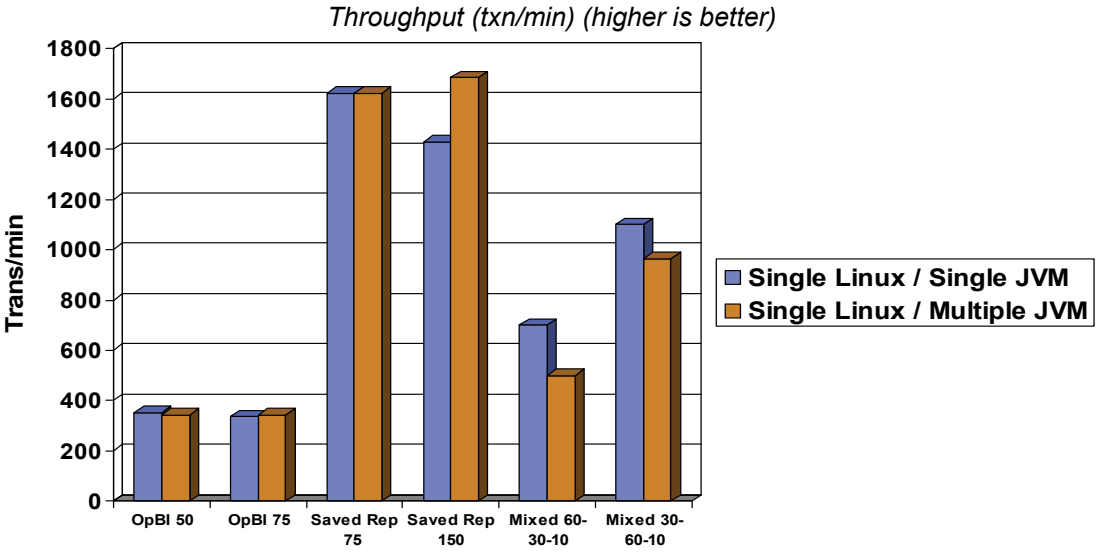


Chart 8. z/VM IBM Cognos 8 BI JVM Deployments -- Transaction Throughput

- The single Linux server with multiple JVM provides much better response time for the OpBI transaction which exercises many IBM Cognos 8 BI functions. This is likely due to better memory utilization and less garbage collection with additional JVMs to support the concurrency level and additional processes. In the SavedRep,

fewer Cognos processes are utilized, and the response time is comparable between the two cases.

- Whether a single JVM or multiple JVMs in a single server provides the best throughput appears to be more workload and concurrency level dependent. Also, overall CPU utilization only reached a maximum of around 80% in both cases. With z/VM, additional guests may be implemented to consume the unused CPU capacity. Further investigation will occur in a future project to understand the causes of the lower maximum utilization and how additional guests may improve throughput and response time.

- Not examined in our study, but a definite consideration, is a potential business requirement to track system resource usage by application area or workload type. With a single JVM for multiple applications, additional monitoring and reduction tools may be needed to meet this requirement.

Scenario 4: IBM Cognos 8 BI and processor scalability

We measured three CPU variations - 2, 4, and 8 virtual processors – using the single server, single JVM configuration described above to assess processor scalability.

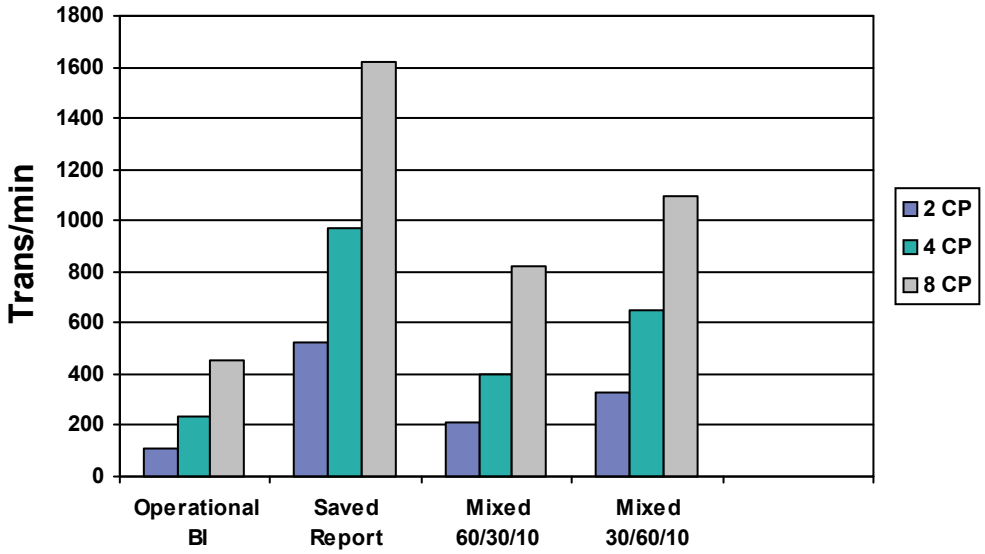


Chart 9. IBM Cognos 8 BI on System z processor scalability - 2, 4, 8 CPUs

- IBM Cognos 8 BI exhibits excellent scalability on Linux for System z with our measured workloads. As the number of processors is doubled, the transaction completion rate also doubles.

Appendix

Minimum Recommended System Requirements

These are minimum recommended system resources and do not imply an appropriate configuration for a product ready platform to support IBM Cognos 8 BI applications. Please consult a qualified IBM Technical Solutions Architect for capacity planning and system sizing estimates.

- IBM Cognos 8 BI v8.4
- System z9
- Two Integrated Facilities for Linux (IFL)
- Four GB real memory
- 2.5 GB disk for installation and 4 GB for Temp space on each server instance
- z/VM 5.3 and SUSE Linux Enterprise Server 10
- Other configurations are supported

For information related specifically to the installation and configuration of IBM Cognos 8 BI, please refer to the "IBM Cognos 8 Business Intelligence Installation and Configuration Guide".