Effectively running IBM Cognos BI for Linux on z Systems in a z/VM environment

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Agenda

- Cognos Business Intelligence (BI) - System Under Test overview
- Cognos BI 10.2 tuning and setup
- z/VM setup and the Resource Manager (VMRM)
- Performance study

Acknowledgements
I wish to acknowledge the help provided by Thomas Weber, performance specialist at the end-to-end performance team in the IBM Boeblingen Lab, Germany
“Know the past, understand the present, shape the future.”

IBM Cognos Business Intelligence (BI):
• Web-based application suite
• Software suite with typical components (web portal, content manager, report server)
• Provides techniques and tools to turn raw data into meaningful information
• BI techniques can handle large amounts of unstructured data
• BI allows easy interpretation of large volumes of data
• Helps to identify and develop new strategic business opportunities
Cognos Business Intelligence for Linux on z Systems

Cognos BI Server as a 3-tier model

- **Data tier**
  - Cognos Content Store
  - DataSource

- **Application tier**
  - Dispatcher
    - Cognos Content Manager
  - Dispatcher
    - Cognos Report Server

- **Presentation tier**
  - Cognos Gateway
  - Dispatcher
    - Cognos Report Server

The diagram illustrates the 3-tier model of Cognos BI Server, with the Data tier handling data access, the Application tier processing and serving requests, and the Presentation tier delivering the final user experience.
Linux on z Systems end-to-end project

Involved Teams
- Linux on z Systems end-to-end performance team
- IBM z Systems Cognos BI performance team

Setup
- z/VM virtualized environment
- z/VM Resource Manager setup (VMRM)
- Distributed installation of Cognos BI Server core components
  - Cognos Gateway
  - Cognos Content Manager
  - Cognos Report Servers

Performance study
- Cognos BI workload should get enough CPU resources when constraint
- Concurrent workloads (DayTrader)
- Static and dynamic tuning of z/VM virtual machine CPU resources
- Technical White Paper
Cognos BI Server Components (1)

Cognos BI Gateway

- Web communication is done through a gateway
- Installed on one more webservers
- Webserver extension (CGI script or Apache module) e.g. for IBM HTTP Server (IHS)
- Receives client requests and passes them to the first registered Cognos dispatcher
- Static connection to a dispatcher
- Does no work balancing or routing of requests
Cognos BI Server Components (2)

Cognos BI Content Manager

- Corner stone in every Cognos BI installation
- Ensures integrity of the Content Store database
- Requires an application server (e.g. WAS)
- Only one active at a time
- Multiple can be configured (failover)

Cognos BI Content Store

- Relational database
- Content Manager maintains the Content Store
- Represents the Cognos BI server meta data repository (e.g. report definitions, security roles, data models,..)
Cognos BI Server Components (3)

Cognos BI Report Server

- Runs requests forwarded by the Cognos BI Gateway
  - Reports
  - Analysis
  - DB queries

- Load balancing over the Cognos BI Dispatcher

- Requires an application server (e.g. WAS)

- Multiple instances of Cognos BI Report Servers possible

Cognos BI Data Store

- Relational database

- Holds sample database data for the test
System Under Test (SUT) – Cognos BI

Websphere Application Server Network Deployment:
Cognos BI WAS Deployment Cell: WAS Deployment Manager + Cognos BI WAS Nodes
Concurrent Workloads (DayTrader) - (1)

- Concurrent workload
- Open Source benchmark application
- Emulates an online stock trading system
- End-to-end Java EE (Enterprise Edition) web application
- IBM WAS is a Java EE application server

http://geronimo.apache.org/GMOxDOC30/daytrader-a-more-complex-application.html
Concurrent Workloads (DayTrader) - (2)

3x DayTrader installations as concurrent workload

- **2x DayTrader triplets (multiple virtual machines)**
- IBM HTTP server + AppServer + DB Server (each two of them in a single machine)

- **1x DayTrader combo (single virtual machine)**
- IBM HTTP server + AppServer + DB Server in a single machine

http://geronimo.apache.org/GMOxDOC30/daytrader-a-more-complex-application.html
**Complete System Under Test (SUT)**

**virtualized SUT running under z/VM:**
- 14 Linux guests
- Ratio of CPU overcommitment **4.2 : 1 (42:10)**
- Ratio of Memory overcommitment 1.3 : 1 (90GiB:70GiB)
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Cognos BI Gateway tuning (1)

- Webserver extension; e.g. for IBM HTTP Server (IHS)
- Gateway knows the location of the primary Cognos BI Dispatcher service

Basic Gateway processing when receiving a request
- Encrypts password to ensure security
- Extracts information needed to submit the request to the Dispatcher
- Attaches environment variables for the web server
- Proper handling of Cognos BI namespaces
- Passes requests to the Dispatcher for processing

Usage of Apache modules on IBM HTTP Server (IHS)
- Replaces the default CGI gateway by an Apache module (apache_mod)
- Requires a change in the IHS configuration file (httpd.conf)
- Add Apache module at the end of the IHS load module list
- Provides enhanced performance and throughput

LoadModule cognos_module <cognos10_location>/cgi-bin/mod2_2_cognos.so
Cognos BI Gateway tuning (2)

Provide enough (virtual) CPUs!

- Same workload level for 2 and 4 CPU measurement series
- Note that the CPU load is not fully bound in the 2 CPU case
- Transaction throughput increases up to 17% by using 4 CPUs in the 10 Cognos users setup
Cognos BI Report Server Java tuning (1)

Websphere Application Server Java Virtual Machine heap size

- Cognos BI Report Server runs as a WAS application
- WAS JVM heap was increased to initial / maximum 1024MB / 2048MB
- A larger JVM heap size often improves the performance
- Monitor the JVM heap over time to find a reasonable heap size
- Consider the memory size of the z/VM virtual machine and other running services

• Screenshot: IBM Pattern Modeling and Analysis Tool for Java Garbage Collector
Cognos BI Report Server Java tuning (2)

**Websphere Application Server web container thread pool**
- Web container handle Java server-side code requests for servlets, JavaServer Pages (JSP) etc.
- Initial values for Maximum Size suitable for simple web applications
- Adapted values improve scalability for more complex applications like Cognos BI
- Maximum number of WebContainer threads was increased to 500

**WAS administration console path:**
Servers -> Application Servers
-> <servername>
-> Thread Pools -> WebContainer

<table>
<thead>
<tr>
<th>General Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
</tr>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Minimum Size</td>
</tr>
<tr>
<td>Maximum Size</td>
</tr>
<tr>
<td>Thread inactivity timeout</td>
</tr>
</tbody>
</table>

- Allow thread allocation beyond maximum thread size
Cognos BI Report Server report service tuning (1)

Number of Cognos BI Report Server service processes
- Dispatcher assigns a requests to a report service process
- Processes that the report service can start is limited (BIBus processes)
- Tuning depending on workload patterns
- Maximum number of parallel report service processes is configurable (long running reports)
- High and low affinity is configurable (many short running reports)

Rule of thumb when choosing the number of processes
- Configure based on the available CPUs
- Report processing is mainly a CPU-bound process
- Single report service processes can grow over 1 GiB
- Consider also the memory footprint of the Report Server

Allow twice as much the number of processes for the report service for the SUT (compared to the default):
Scaling the number of Cognos BI report service processes

- Cognos BI Report Server with 4 CPUs showed best throughput / resource ratio
Cognos BI Report Server report service tuning (3)

Memory footprint of 4 active report service processes

Memory consumption of 4 report service processes over time
Cognos BI Report Server Query Service

Query Service – Java heap size
- Initial and maximum heap size was increased to 4096 MiB

<table>
<thead>
<tr>
<th>Tuning</th>
<th>Initial JVM heap size for the query service (MB) (Requires QueryService restart)</th>
<th>4096</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuning</td>
<td>JVM heap size limit for the query service (MB) (Requires QueryService restart)</td>
<td>4096</td>
<td>No</td>
</tr>
</tbody>
</table>

Overall Report Server memory footprint
- Cognos BI Report Server tuning can result in a large memory footprint
- Consider the following memory-consuming components
  - WAS JVM heap size (max. 2 GiB)
  - Query Service JVM heap size (4 GiB)
  - Report service processes can get bigger than 1 GiB per process

==> **Cognos BI Report Server can quickly get a large memory footprint**
==> Report Servers for the SUT were sized with 16GiB each
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Control virtual machine CPU capacity (1)

z/VM introduces shares to control the CPU for a virtual machine

- Share concept applies when the z/VM hypervisor is CPU constraint

- **ABSOLUTE share**
  - Allocates an absolute portion of all z/VM processors for a virtual machine
  - Guarantees a certain percentage of processing time
  - No usage of ABSOLUTE shares for this project

- **RELATIVE share**
  - Allocates a relative portion of the z/VM processors for a virtual machine
    (less than any allocations for ABSOLUTE shares)
  - RELATIVE share is an integer number between 1 to 10000
    (larger number means higher share)
Control virtual machine CPU capacity (2)

Definition of the fair share setup

- Used for all non-VMRM tests in this project
- Default RELATIVE share for a virtual machine is **100**
- Fair share setup == assigns a RELATIVE share of **100** per virtual CPU
- Ensures that each virtual CPU has the same weight within z/VM

Example

- Virtual machine VM1 has **2** virtual CPUs: RELATIVE fair share is **200**
- Virtual machine VM2 has **4** virtual CPUs: RELATIVE fair share is **400**

VM2 can get twice as much CPU time for its 4 CPUs than VM1
z/VM Resource Manager VMRM (1)

VMRM can dynamically tune a z/VM virtual machine CPU shares

- Virtual machines can be members of workload groups
- Workload groups will be managed according to defined goals
- VMRM automatically adjusts performance parameters to achieve the goals
- Only effective in constrained environments

- CP monitor data is used to obtain a virtual machine's resource consumption
- Requires a service virtual machine VMRMSVM

- Other tunable resources are memory and DASD I/O

Note
- VMRM Cooperative Memory Management (CMM) is not used in this project
- VMRM velocity targets for DASDs are not used in this project
z/VM Resource Manager VMRM (2)

Service virtual machine VMRMSVM

- Starts VMRM by calling the IRMSERV EXEC program

- Reads user supplied configuration file (default: VMRM CONFIG A)
  - Definition of workloads, goals, priorities

- VMRM adjusts virtual machine tuning parameters
  - Using CP Command 'SET SHARE' for CPU shares
  - Done for “eligible” virtual machines in a defined workload group

- VMRM interaction with the CP monitor
  - Starts sample monitoring if not already active
  - Default: 60 sec sample monitoring interval

- VMRM screen in the z/VM Performance Toolkit (FCX241)
  - See backup
z/VM Resource Manager VMRM (3)

Sample VMRM configuration file with CPU velocity goals

```
ADMIN  MSGUSER  VMRMADMN
GOAL  COGCP*  VELOCITY  CPU  70
GOAL  DAYCPU  VELOCITY  CPU  25
WORKLOAD  DAYTRADER  USER  TRDUSR*
MANAGE  DAYTRADER  GOAL  DAYCPU  IMPORTANCE  1
WORKLOAD  COGNOS  USER  COGUSR*
MANAGE  COGNOS  GOAL  COGCP*  IMPORTANCE  10
```

**ADMIN** - identifies a user to receive VMRM messages

**GOAL** - used CPU velocity goals (1-100)

**WORKLOAD** - describes a workload by userid, account id, or acigroup

**MANAGE** - associates a workload with a goal and assigns an importance value 1(lowest) – 10(highest)
**Influence of the CP monitor sample interval**

- Measurement series with different sample intervals (default 60 sec)
- Slightly better results with smaller intervals 30 and 15 sec
- Interval of 30 sec has been chosen for the complete VMRM measurement series
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**Workload for Performance study (1) – Cognos BI**

- Custom benchmark application running on an external x86 machine
- Workload is forming a typical Cognos BI transaction mix
- Multiple users can run the transaction mix

<table>
<thead>
<tr>
<th>Cognos BI scenario</th>
<th>Workload share</th>
</tr>
</thead>
<tbody>
<tr>
<td>interactive reporting and ad hoc analysis</td>
<td>30%</td>
</tr>
<tr>
<td>use of Dynamic Query Mode (DQM)</td>
<td></td>
</tr>
<tr>
<td>chart and report creation</td>
<td>20%</td>
</tr>
<tr>
<td>using the new charting engine</td>
<td></td>
</tr>
<tr>
<td>dashboard activity</td>
<td>30%</td>
</tr>
<tr>
<td>users open multiple pages in a webbrowser session</td>
<td></td>
</tr>
<tr>
<td>retrieve PDF reports</td>
<td>10%</td>
</tr>
<tr>
<td>users access saved PDFs reports in the Content Store</td>
<td></td>
</tr>
<tr>
<td>retrieve HTML reports</td>
<td>10%</td>
</tr>
<tr>
<td>users access saved HTML reports in the Content Store</td>
<td></td>
</tr>
</tbody>
</table>
**Workload for Performance study (2) – Cognos BI**

- Different Cognos BI CPU load levels used within the study
- Load varies with number of active users
- Multiple users can run the transaction mix in parallel

<table>
<thead>
<tr>
<th>Cognos BI CPU load level</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cognos70</strong></td>
<td></td>
</tr>
<tr>
<td>5 users</td>
<td></td>
</tr>
<tr>
<td>approx 70% IFLs used</td>
<td></td>
</tr>
<tr>
<td>default load level for Cognos BI</td>
<td></td>
</tr>
<tr>
<td><strong>Cognos90</strong></td>
<td></td>
</tr>
<tr>
<td>10 users</td>
<td></td>
</tr>
<tr>
<td>approx 90% IFLs used</td>
<td></td>
</tr>
<tr>
<td>used for some selected scenarios</td>
<td></td>
</tr>
<tr>
<td><strong>Cognos95</strong></td>
<td></td>
</tr>
<tr>
<td>15 users</td>
<td></td>
</tr>
<tr>
<td>approx 95% IFLs used</td>
<td></td>
</tr>
<tr>
<td>used for some selected scenarios</td>
<td></td>
</tr>
</tbody>
</table>

Cognos BI Server - LPAR CPU Load (10 IFLs)

- 5 users → 'Cognos70'
- 10 users → 'Cognos90'
- 15 users → 'Cognos95'

![Graph showing CPU utilization over time for different load levels](image-url)
Workload for Performance study (3) – DayTrader

- Different DayTrader CPU load levels used within the study
- Load varies with number of acting users
- Load levels are for 3 parallel running DayTrader Apps (2 triplets + 1 combo)

<table>
<thead>
<tr>
<th>DayTrader CPU load level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DayTrader25</td>
<td>5 users each approx 25% of 10 IFLs used low load level</td>
</tr>
<tr>
<td>DayTrader50</td>
<td>125 users each approx 50% of 10 IFLs used medium load level</td>
</tr>
<tr>
<td>DayTrader75</td>
<td>190 users each approx 75% of 10 IFLs used high load level</td>
</tr>
</tbody>
</table>
Performance study – Fair share setup

- All virtual CPUs have the same relative share (100 per CPU)
- Mixed workload (Cognos BI + DayTrader workload in parallel)
- Single DayTrader combo has the highest relative share 600
- DayTrader triplets relative shares 100/400/200
- Cognos BI gateway, report servers relative shares 400/400/400

**Workload CPU load level**

**Cognos70 + DayTrader25**
High workload with IFL load close to 100%; some peaks above

**Cognos70 + DayTrader50**
Higher workload with IFL load above 100% (full constrained)

**Cognos70 + DayTrader75**
Highest workload with IFL load above 100% (full constrained)
Performance study – VMRM setup (1)

- Relative CPU shares are modified by VMRM according to the workload goals
- Mixed workload (Cognos BI + DayTrader) in two different workload groups
- Cognos BI workload has a **high** CPU velocity goal
- DayTrader workload has a **low** CPU velocity goal

<table>
<thead>
<tr>
<th>Workload CPU load level</th>
<th>VMRM settings used for this study</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cognos70 + DayTrader25</strong></td>
<td><strong>Fixed</strong> (determined by tests)</td>
</tr>
<tr>
<td>high workload with IFL load close to 100%; some peaks above</td>
<td>• CP monitor sample interval: 30 seconds</td>
</tr>
<tr>
<td><strong>Cognos70 + DayTrader50</strong></td>
<td>• Goal importance: 10 (high) for Cognos BI</td>
</tr>
<tr>
<td>higher workload with IFL load above 100% (full constrained)</td>
<td>1 (low) for DayTrader</td>
</tr>
<tr>
<td><strong>Cognos70 + DayTrader75</strong></td>
<td><strong>Varied</strong></td>
</tr>
<tr>
<td>highest workload with IFL load above 100% (full constrained)</td>
<td>• CPU velocity goal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CPU velocity goal</th>
<th>for Cognos BI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cogn:60 DayTr:25</td>
<td>moderate high</td>
</tr>
<tr>
<td>Cogn:70 DayTr:25</td>
<td>high</td>
</tr>
<tr>
<td>Cogn:80 DayTr:25</td>
<td>high</td>
</tr>
<tr>
<td>Cogn:100 DayTr:1</td>
<td>maximum possible</td>
</tr>
</tbody>
</table>
Performance study – VMRM setup (2)

Cognos BI throughput for different VMRM CPU velocity goals

- VMRM CPU velocity goals guarantee a certain throughput level
Performance study – VMRM setup (3)

Cognos BI response times for different VMRM CPU velocity goals

- VMRM CPU velocity goals guarantee a certain response time
Performance study – VMRM managing workload peaks (1)

Scenario 1: “Give others a chance”

- Cognos BI CPU goal 70 and DayTrader CPU goal 25
Performance study – VMRM managing workload peaks (2)

Scenario 1: “Give others a chance”

- VMRM relative share adaption according to the CPU velocity goals
Performance study – VMRM managing workload peaks (3)

Scenario 2: “Cognos BI gets all”

- Cognos BI CPU goal 100 and DayTrader CPU goal 1
Performance study – VMRM managing workload peaks (4)

Scenario 2: “Cognos BI gets all”

Cognos BI + DayTrader peak workload - relative shares (selected guests)

workload peak with Cognos 70 load
VMRM CPU goals: Cognos 100 / DayTrader 1

- VMRM relative share adaption according to the CPU velocity goals
Performance study – VMRM managing workload peaks (5)

Cognos BI throughput - compare all scenarios

- Maximum velocity goal almost maintains Cognos BI throughput level
Questions?

● Further information
  
  - For more detailed information see the available White Paper
    “IBM Cognos Business Intelligence 10.2.1 for Linux on System z – Performance and z/VM
    Resource Management” (ZSW03268-USEN-00)
    http://www.ibm.com/developerworks/linux/linux390/perf/tuning.vm.html#cog
  
    Linux on z Systems – Tuning hints and tips

  - Live Virtual Classes for z/VM and Linux
    http://www.vm.ibm.com/education/lvc/

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 Mario Held
 Linux on z Systems
 Performance Analyst

Complete your session evaluations online at www.SHARE.org/Orlando-Eval
Backup
In the VM Resource Manager Screen (FCX241), the names of workloads which have been active during the last measuring interval are highlighted on the screen.

### Layout of VM Resource Manager Screen (FCX241)

<table>
<thead>
<tr>
<th>VM Resource Manager</th>
<th>Workload</th>
<th>CPU nnnn</th>
<th>Server</th>
<th>Perf. Monitor</th>
<th>Impor</th>
<th>D-Goal</th>
<th>D-Act</th>
<th>C-Goal</th>
<th>C-Act</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMRMSVM</td>
<td>WORK1</td>
<td>10</td>
<td>10</td>
<td></td>
<td>100</td>
<td>...</td>
<td>100</td>
<td>...</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>VMRMSVM</td>
<td>WORK2</td>
<td>5</td>
<td>50</td>
<td></td>
<td>50</td>
<td>...</td>
<td>50</td>
<td>...</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>VMRMSVM</td>
<td>WORK3</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
<td>...</td>
<td>1</td>
<td>...</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>VMRMSVM</td>
<td>WORK4</td>
<td>10</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>87</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VMRMSVM</td>
<td>WORK5</td>
<td>5</td>
<td>50</td>
<td>100</td>
<td>50</td>
<td>43</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VMRMSVM</td>
<td>WORK6</td>
<td>1</td>
<td>1</td>
<td>100</td>
<td>1</td>
<td>7</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VMRMSVM</td>
<td>WORK7</td>
<td>10</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>83</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VMRMSVM</td>
<td>WORK8</td>
<td>5</td>
<td>50</td>
<td>100</td>
<td>50</td>
<td>41</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VMRMSVM</td>
<td>WORK9</td>
<td>1</td>
<td>1</td>
<td>...</td>
<td>1</td>
<td>...</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The information shown is based on CP monitor application data domain SAMPLE data.
**Networking**

z/VM Virtual Switch (VSWITCH) for virtual machine communication

- Good performance
- Recommended method for internal and external z/VM network connectivity
- Special purpose GuestLAN
- Linux reports (lsqeth) it as card_type “GuestLAN QDIO”