DB2 Performance Tuning: Where do we start?

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So many places to look...

And adjust...
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Agenda

- **The politics of performance**
  - The data base administrator role
  - Management expectations
  - DBA expectations

- **Performance Tuning**
  - Graphs and Trends
  - Playbooks

- **DB2 biggest performance issues**

- **Tooling**

- **Performance Touch Points with DB2 for z/OS**
The database administrator role

- Protection of the company’s data assets
- Availability of the company’s data assets
- Fast delivery of the company’s data assets
- Provide analysis on problems as required

Protection, Availability, and Speed are the goals.
Protection of the company's data assets

- Adequate backup and recovery
- Retention of logging media
- Ensuring adequate storage and retention of logs and backups
- Performing disaster recovery scenarios
Performance aspect – application and SQL, maintenance

Availability of the company's data assets

- Reviewing data paths into and out of the DBMS
  - Efficiency
  - Connections
  - Minimal server "hops"
  - Outage prevention
- Routine maintenance (data growth)

- Application usage (OLTP vs Batch vs BI)
- SQL coding

- Maintenance
- Manage for growth
- Data archival/purges
Performance aspect – SLA/SLO

Fast delivery of the company's data assets
- Creation of and meeting service level objectives
- Access paths and access strategies
- Ensure the data is delivered as quickly and efficiently as possible

- Performance data collection
- Measurable SLA/SLOs
- Object placement and I/O
Management’s expectation & perspective

• Ability to look at the overall environment
• Make projections on the growth
• Plan for any future projects

Motivation: To rein in spending and control costs

To an I.T manager perspective:

• Making a pretty good estimate on how much the overall environment will grow
• Resolve outstanding issues that would enable postponing upgrades
• Not being blindsided by an issue not caught by the database administration staff
Data base administrator's perspective

- Faster mean time to problem resolution
- Get to the problem faster than having the users complain to his manager

Motivation: To not be blindsided by a problem

To a DBA this translates to:
- Monitoring by rules
- Responding quickly to the problems when they happen
- Planning for that next growth issue
A few words on performance “politics”

• Usually do not happen when applications are…
  • Unit tested
  • System tested or shakedown tested
  • Integration tested

• But when they happen, DBAs ask…
  • Is this a one-off situation?
  • Or is this a new “steady state”? 
    • New workload
    • Existing work changes
    • DBA misstep

The DBA “unwritten” Code
(1) To minimize problem phone calls
(2) To make the on-call rotation a non-item task
(3) To never receive the problem from your boss
A few words on performance “myths”

“…If we tune the environment, we can reduce MIPS being used by the application…”

“…Performance tuning is easily resolved by finding the spikes and correcting for those spikes…”

“…We’re getting performance problems in ______. We did not change anything…”

Better approach:
• Tune the application
• Put the “spikes” in context
  • New app(s)?
  • Change in app(s)?
  • Change in environment?
  • Continued growth?
• Consistent measurement – How do you know there is poor performance?
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Performance problems come in two main flavors
- Localized, impacting a subset of statements or applications
- Broad-scope, impacting the entire system
- Many individual problems can combine to create a system-level symptom!

- System-wide symptoms - Many / most / all things run poorly
- Localized symptoms - Plan problems, resource hot-spots, etc.

- System-wide causes - Poor configuration, inadequate resource, etc.
- Localized causes - SQL problems, resource hot-spots, etc.
Usage and Growth

- **Organic**: Linear increase in capacity over time.

- **New/changed application**: Capacity increase followed by stabilization, indicating observed behavior.

- **Occasional**: Capacity spikes over time, showing occasional high usage.

- **Spikes**: Sharp increases in capacity at specific points in time, indicating spikes.

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Usage and Growth

Organic

New/changed application

Occasional

Spikes

Data Growth:
- Old statistics
- I/O bottlenecks

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Usage and Growth

**Organic**

- Capacity over Time

**New/changed application**

- Installation success
- But...
- Data grows with use
- Widespread adoption

**Occasional**

- Capacity over Time

**Spikes**

- Classic TIP-TOP
Usage and Growth

Organic

New/changed application

Occasional

Spikes

Was everything tested with this change?
Usage and Growth

- **Organic**
  - Most likely causes:
    - Ad-hoc queries...
    - ...in PRODUCTION

- **New/changed application**

- **Occasional**

- **Spikes**
  - Secondary cause:
    - Competition for resources

See Next Chart!!!!
Spike analysis technique

- Look for the spikes in anything and do cross-comparisons
- Adjust one setting at a time to correct
  - SQL spike:
    Correct (tune) SQL and cross collaborate with table activity
  - I/O spike:
    Review type of activity, cross collaborate with bufferpool and SQL activity
  - Bufferpool spike:
    Review type of spike, cross collaborate with I/O and SQL activity
  - Memory spike:
    Cross compare with bufferpool, I/O and SQL activity
  - Locking issues:
    Review application for commit behavior, tune SQL, change config parameters.

On to the Playbooks...
Non-spike analysis technique

- Best used with I/O (SMF type 42)
- Look at calculated total response time and sort descending
  \[ \text{I/O AVERAGE RESPONSE TIME} \times \text{TOTAL NUMBER of I/Os} \]
- Top 1,000 highest times
- Find Low, medium, and high ranges
- Isolate as…
  - Steady
  - Occasional
  - Spikes

Next slide shows example
Where is the real bottleneck?

High Range
Medium Range
Low Range

Medium Steady I/O
High Steady I/O
Low Steady with High Occasional I/O with spikes
I/O usage analysis

Buffer pools used: Overuse found on BP6 and BP7

High-usage / spiked repository datasets

Heavy-usage tables
Performance tuning playbooks DB2 for z/OS

New application on a new subsystem:

- zParm settings
- Above/below the line memory allocations
- WLM settings for service class pertaining to DB2
- SQL
  - If less than 5 SQLs running slow, tune the SQL
  - If more than 5 SQLs running slow, look at the I/O and bufferpool
- Locking behavior

*Jeffy’s Rule-of-10 (next slide!)*
Sidebar: Why 5 SQL statements?

• Jeffy’s rule of “10”
  • Most I/O is caused by no more than 10 tables/indexes
  • No more than 10% of all I/O data show high usage sync activity
  • Most applications have a top 10 list of poor performing SQL

• Of the top 10 poor performing SQL…
  • There are 2 to 3 versions running concurrently
  • Therefore, average of 5 SQL statements

Back to the Playbooks…
Performance tuning playbooks DB2 for z/OS

New application on an existing subsystem hosting applications:

- Activity in the buffer pools and I/O
- SQL
  - If less than 5 SQLs running slow, tune the SQL
  - If more than 5 SQLs running slow, look at the I/O and bufferpool
- Locking behavior
- Capacity like tablespace growth
Performance tuning playbooks
DB2 for z/OS

Change to an existing application:

- SQL
  - If less than 5 SQLs running slow, tune the SQL
  - If more than 5 SQLs running slow, look at the I/O and bufferpool
- Locking behavior
- Activity on the subsystem
Performance tuning playbooks
DB2 for z/OS

No perceptible change whatsoever
(application and environment)

- Organic growth
- Something unexpected is running

How did “you” hear about the problem?
- Tool showed problem
- Identified by an end-user or application programmer

What should be researched?
- Check for something unexpected additional (Heavy utilities running)
- SQL to find the long running queries, then
- RUNSTATS on tables identified in the long running queries
- Followed by a health check across-the-board
- Trend analysis and capacity planning like table space growth
A Thoughtful, Enlightened Strategy

Structured, methodical, closed-loop approach

- Be prepared! Understand how the system works when things are well
- Look at high-level performance symptoms with tooling
  - Optim Performance Manager
  - Omegamon XE
  - Iostat / db2look
  - Resource Management Facility
  - Other tools
- “Divide and conquer” the problem
  - What causes do the symptoms indicate?
  - What do they rule out?
- Make one or more hypotheses
- Important: change one thing at a time!

Problem Solved?
N  Y
:::-)

UNDERSTAND
the system when all is well

OBSERVE
the data available to you when a problem occurs

THINK
about what problems that data might represent

CHANGE
one element of the system
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• DB2 biggest performance issues

• Tooling

• Performance Touch Points with DB2 for z/OS
DB2 biggest performance issues

Underestimating the effects of …

• the DB2 setup
• the I/O (DB2 for z/OS)
• poorly written SQL
• the workload
DB2 setup - Buffer pool strategy

- All I/O is buffered, no direct reads
  - DB2 does many operations autonomously (Predictable)
  - Unexpected things in the buffer pool (Unpredictable)
- DB2 has to “drop what it is doing” to perform a read
- Contention
  - Buffer pool too small
  - Competition within the pool
  - Threshold settings not reflective of usage

DB2 9 for z/OS: Buffer Pool Monitoring and Tuning
http://www.redbooks.ibm.com/redpieces/abstracts/redp4604.html
DB2 setup - Connections

- Know thy traffic
  - Application traffic
  - Server-to-server traffic and latency
  - Workload and usage
- Contention
  - Number of hops
  - Latency
  - Number of connections
  - Settings not reflective of usage
Underestimating the I/O – High usage objects/Logical Control Unit

- Highly used DB2 objects
  - Table spaces
  - Index spaces
- Highly used disk controllers
- Combination of both

DB2 9 for z/OS and Storage Management (SG24-7823-00)
Poorly written SQL and the workload

• Dynamic SQL challenge
• Need to find the “bad” SQL
• How do you know the “good” SQL from the “bad” SQL
• Situation of execution
  • One-off inconsistent
  • Same time / same day-of-week but different day
  • Did it just start happening without change
• Dynamic SQL – Finding the application
Sequence to the Hunt for Bad SQL

- Capturing the SQL
  - On-line monitors
  - If that doesn’t work, set a trace
- Analyzing/Tuning the SQL
- Getting the SQL changed
  - Hopefully there is a feedback/code review process
  - Regression test “sandbox”

Omegamon XE or equivalent
- Scanning the dynamic statement cache:
  - Data Studio Standalone
  - Optim Query Tuner
  - Query Workload Tuner

Optim Query Tuner for DB2 for z/OS or equivalent
- Data Studio Standalone:
  - Query formatter
  - Access plan graph
  - Statistics advisor

Optim Performance Manager
- pureQuery
  - Static binding plus WLM
You have the SQL, now what?

1. Minimize I/O
   - Find in the buffer pool
2. Minimize synchronous activity
   - Have DB2 predictably prefetch into the buffer pool
3. Combine SQL operations to minimize CPU instructions
   - Find an SQL guru
   - Use tooling
     - OQT - Tune SQL pre-production while costs and impact are low
     - OQWT - Optimize workload for peak performance
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Tooling in Performance Management

DB2 for z/OS
- OMEGAMON XE DB2 Performance Expert
- OMEGAMON XE DB2 Performance Monitor
- DB2 Buffer Pool Analyzer
- Optim Query [Workload] Tuner
- DB2 Query Monitor
- DB2 Performance Toolkit SAP Edition

DB2 for LUW
- Optim Performance Manager
- Optim Query Tuner

IBM Optim Performance Manager for DB2 for Linux, UNIX, and Windows
DB2 Developer Workbench vs. Data Studio

before

IBM DB2 Developer Workbench V9.1
- SQL Query Editor
- SQLJ Editor
- SQL Builder
- XQuery Builder
- SQL Routine Debugger
- Java Routine Debugger
- XML Editor
- XML Schema Editor
- Data Management
- Visual Explain
- Project Management

Data Studio is a full replacement of DB2 Developer Workbench plus much more

- DB2 for Linux, Unix, Windows v8.x, v9.x
- DB2 for z/OS v7, v8, v9
- DB2 for i5/OS v5r2, v5r3, v5r4
- Informix Dynamic Server (IDS) v9.x, v10.x, v11

now

IBM Data Studio V2.2
- Integrated Query Editor – SQL + XQuery
- SQLJ Editor
- SQL Builder
- XQuery Builder
- SQL Routine Debugger
- Java Routine Debugger
- XML Editor
- XML Schema Editor
- Data Management
- Visual Explain
- Project Management
- ER Diagramming
- Data Distribution Viewer
- Object Management
- Browse & Update Statistics
- Security Access Control
- Connection Management integration with Kerberos and LDAP
- Data Web Services
- IDS Server Support

No-charge

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Data Studio V2.2

Visual Explain made easy in Data Studio V2.2

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Other tooling
DB2 for z/OS high usage objects

- Methods
  - RMF I/O activity by VOLSER reports
  - SMF type 42 records (SMS: subtype 6)
- Observation: There are, on average, 10 tables accessed exponentially above all other tables

SMF Type 42 Parser for zOS
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Performance Touch Points with DB2 for z/OS

DB2 Installation
- SMFACCT=(1,2,3) and SMFSTAT=(1,3,4)
- Log sizes - dual for onsite/offsite

DB2 Usage
- Table spaces sized for manageability
- Buffer pool strategy
- Understand the usage for any new feature
  - PGFIX
  - Use sliding scale if not constrained by DASD

z/OS
- SMF Records
  - Use appropriate interval
  - Type 100:102
  - Type 42
  - Need type 30 records with intervals
Performance Touch Points with DB2 for z/OS

Tooling
- Omegamon XE for DB2 or equivalent
- DB2PE or equivalent
- Data Studio (OSC replacement)
- Optim Query Tuner
- Optim Workload Query Tuner

Optional Tooling
- RMF or equivalent
  - RMF Spreadsheet Reporter
- Optim Performance Manager (DB2 for LUW on zLinux)
Performance Touch Points with DB2 for z/OS – Links to tools

IBM Data Studio and pureQuery
http://www-01.ibm.com/software/data/optim/

DB2 Accessories Suite for z/OS
http://www-01.ibm.com/software/data/db2imstools/db2tools/accessories-suite/

SMF Type 42 Parser for z/OS

IBM Tivoli Monitoring zOMEGAMON and Related Products Best Practices Informational links
Performance Touch Points with DB2 for z/OS - Training

- CV960 - DB2 9 for z/OS Application Performance and Tuning
- CV950 - DB2 9 for z/OS System Performance Analysis and Tuning
- ES545 - Basic z/OS Tuning Using the Workload Manager (WLM)
In Summary

• It is possible to performance tune ad infinitum, ad nauseam...Don’t!
• Tune to the level of what you, your end-users, and the company can live with
• Meet your service level agreements and service level objectives
• Remember these 3 guidelines:
  • Bottlenecks can be either Memory, I/O, or Processor but in most cases it is a combination of factors
  • The limit of any machine is ultimately a bottleneck by definition
  • Workload and performance management is the art of juggling what you can live with
Need a jump-start?
Skill gap?
Need it yesterday?

IBM Systems Lab Services and Training

www.ibm.com/systems/services/labservices
stgls@us.ibm.com ● Systemz@us.ibm.com
Thank You!!!

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Reference Slides
The database administrator - Job description

- **Protection of the company's data assets**
  - Adequate backup and recovery
  - Retention of logging media
  - Ensuring adequate storage and retention of logs and backups
  - Performing disaster recovery scenarios
  - Making sure any recovery performed is done efficiently with little data loss and little outage
  - Jealous data protection and being involved with any change in the system

- **Availability of the company's data assets on an as-required basis**
  - Ensuring the correct security roles and responsibilities are delivered to the correct organizations
  - Reviewing that all required paths into and out of the DBMS are efficient with such things as connections, minimal server "hops", prevention of any outage (including failover of a server in the chain)
  - Making sure all software is up-to-date
  - Performing proactive routine maintenance including REORGs, RUNSTATS, space usage (organic growth), and review of DBMS usage for memory and I/O

- **Fast delivery of the company's data assets to those authorized**
  - Involvement with creation of and meeting service level objectives
  - Reviewing (and creating) table, view, access paths and access strategies with application personal
  - Ensure that the DBMS, the DBMS servers, and the data is delivered as quickly and efficiently as possible

- **Provide analysis on problems as required**

Protection, Availability, and Speed are the goals.
DB2 for z/OS
Buffer Pool Recommendations

- A buffer pool strategy should…
  - Separate, at a minimum, by tablespaces and indexes
  - Separate highly accessed tablespaces and indexes from the less active tablespaces and indexes
  - Separate by random (online, OLTP) versus sequential access
  - Separate by size
- A good subsystem buffer pool strategy should…
  - Put work tablespaces into their own pool
  - Put temporary tablespaces into their own pool
  - DB2 Catalog into their own pool

DB2 9 for z/OS: Buffer Pool Monitoring and Tuning
http://www.redbooks.ibm.com/redpieces/abstracts/redp4604.html
Recommended DB2 buffer pool Strategy

BP0 – DB2 Catalog
BP1 – Small-sized Reference Tablespaces
BP2 – Small-sized Reference Indexspaces
BP3 to BP6, BP8 to BP9 – expansion/isolation for performance bottlenecks in BP1 and BP2
BP7 – Sort DSNDB07

BP10 to BP19 – Tablespace buffer pools
  BP10 – Medium-sized Sequential Access
  BP11 – Medium-sized Random Access
  BP12 – Large-sized Sequential Access
  BP13 – Large-sized Random Access
  BP14 to BP19 – expansion/isolation for performance bottlenecks

BP20 to BP29 – Indexspace buffer pools
  BP20 – Medium-sized Sequential Access
  BP21 – Medium-sized Random Access
  BP22 – Large-sized Sequential Access
  BP23 – Large-sized Random Access
  BP24 to BP29 – expansion/isolation for performance bottlenecks