Optimize Intelligence Platform to Deliver High Performance

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Why Performance is critical?

• As an analogy, think about an under-performing Air Conditioning (AC) unit in your house when temperature gets very high in summer
  • You are constantly irritated since it is hot inside the house all the time
  • Despite your investment in a good AC system, you are not getting the benefit that you desire
  • Unit is constantly running, it drives up your energy (electricity) costs and will wear out sooner than it’s intended lifetime.

• If your enterprise system infrastructure has not been correctly sized or properly tuned
  • Sub-responsive system
  • End user frustration
  • Increased operational and maintenance costs
An inefficiently configured and sub-optimally tuned platform will lead to a lot of user frustration and result in the organization spending more money operating it. This does not augur well for your clients and your user community that is dependent upon the MicroStrategy platform for time critical information.
Intelligence Platform Performance

• Performance is a very vast topic that involves and affects every component in the Intelligence architecture

• In this presentation, the focus is primarily on tuning and optimizing MicroStrategy Intelligence Server for general platform performance

• Performance related to specific topics such as the following are not discussed:
  • Applications (dossiers/documents)
  • Intelligent cube design and publication
  • Web Server and Mobile Server
Agenda

• Governing and Performance Tuning
  • Job
  • User
  • Memory
  • Database connectivity and execution

• Performance Monitoring

• Performance Analysis

• MicroStrategy 2019 Performance Improvements

• Enterprise Support
Resource Contention

• What is resource contention?
  • Sharing of a resource in a way that a management unit (such as an Operating System) spends too much time managing multiple requests for it

• Typical examples:
  • Processes or threads competing for CPU time
  • TCP connections pushing too much data
  • Too many processes/threads sharing RAM
Governing

• What is Governing?
• It is a methodology to:
  • Keep the system healthy
  • Prevent activities that will compromise overall system health

• Why Governing?
• Address the problem of resource contention
• Protect against excessive resource utilization
Governors

- Job
- User
- Memory
- DB connectivity and execution
Job: Processing Units and Threads

• What is a Job?
  • A structure for execution….
  • Jobs go through tasks to complete their work
Job: Processing Units and Threads

• What is a Processing Unit (PU)?
  • A container (manager) for the following:

<table>
<thead>
<tr>
<th>PU Component</th>
<th>Definition</th>
</tr>
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</table>
| Tasks        | • Define work needed to complete a job  
               • Examples: SQL Generation, Query Execution |
| Threads      | • Execute the Tasks belonging to the PU in parallel |
| Queues       | • Assign job Tasks to Threads, FIFO |

What to do?  Who does it?  When is it done?
Job: Processing Units and Threads

• Every Processing Unit (PU) has one or more threads
  • A thread executes a task in the PU
  • A thread can execute only one task at a time
  • Thus, Number of Threads in PU = Number of tasks that can execute concurrently in that PU

• More threads are not necessarily better!
  • Fewer threads = Fewer jobs executing at once, more jobs waiting
  • Fewer threads means more CPU time per thread
  • Jobs may wait longer, but run faster when released from the queue
Job: Processing Units and Threads

• Number of database connection threads can be set in Developer
  • Applies to the PU responsible for Query Execution
  • Query Execution can be time-consuming
  • Effect of governing is easier to see

• Other PUs have thread counts
  • Not Exposed in MicroStrategy Developer
  • Tasks usually complete quickly
  • Incorrect thread counts can cause poor performance
Job: Server Level

- Maximum number of jobs
- Maximum number of interactive jobs
- Maximum number of scheduled jobs

For the above settings:
- If exceeded, jobs are rejected
- Tracking lots of open jobs takes CPU time and memory
- Jobs created for datasets (within documents/dossiers) can be excluded from the job count
- Recommend setting finite values rather than -1
Job: Project Level

- Jobs per user account
- Jobs per user session
- Jobs per project
  - Interactive jobs per project
  - Scheduled jobs per project

For the above settings:
- If exceeded, jobs are **rejected**
- Recommend setting finite values rather than -1
Job: Executing jobs per user

• Maximum number of jobs per user that may be **executing** in the same **Processing Unit** simultaneously
• If exceeded, new jobs are queued
• “Waiting” jobs don’t count
• Prevent a single user from taking up significant resources
• Element requests are excluded
• Recommend setting to a finite value rather than -1.
Governors

- Job
- User
- Memory
- DB connectivity and execution
User Sessions: Server Level

- Maximum number of user sessions
  - Limits the total number of user sessions in Intelligence Server
  - If exceeded, sessions are rejected

- Limit user session idle times helps to free up system resources
  - User session idle time (sec)
  - Web user session idle time (sec)
    - Idle users will take up working set memory
  - Scheduler session timeout (sec)
User Sessions: Project Level

• User sessions per project

• Concurrent interactive project sessions per user
  • Limits the number of concurrent sessions per user per project
  • Useful under the following circumstances:
    • Web users open new sessions in a new browser window without logging out of the previous one
    • One user account such as “Guest” is used for multiple sessions
Governors

- Job
- User
- Memory
- DB connectivity and execution
Memory Settings

• Server Level
  • Memory Contract Management
  • Working Set
  • Web User Session Recovery
  • SmartHeap
  • File Generation

• Project Level
  • Caches
    • Result Caches (dataset, document, dossier)
    • Object and Element caches
  • Intelligent Cubes
  • Result Sets
Memory Settings: Memory Contract Management

- Enable Memory Contract Management (MCM)
  - Prevent Intelligence Server from shutting down under high memory usage conditions
- Minimum reserved memory
  - Reserve memory for external processes to cushion against memory spikes
  - Recommend 10% or a suitable value (MB)
    - For larger RAMs, setting a value may be more appropriate than a percentage
- Single memory allocation governing
  - Enable as needed
  - May be suitable for ad-hoc jobs
Memory Settings: Working Set Cache

- Working Set is a memory repository for report/document instances across all users and all sessions
  - Allows efficient use of web browser's Back button
  - Improves web performance for manipulations
  - Allows users to manually add messages to History List

- Maximum RAM for Working Set cache
  - Set to 25% of available RAM or to a suitable value based on the Working set cache RAM usage counter
Memory Settings: Web User Session Recovery on Logout

• Enable Web User Session Recovery on Logout
  • Allows users to recover report, document they were on when the session ended

• Turn this OFF
  • Disable this setting in production
  • Setting will cause high memory usage and heavy disk utilization
Memory Settings: SmartHeap

- SmartHeap is a memory management software embedded with Intelligence Server
  - Designed to maximize memory allocation performance

- Configure SmartHeap to automatically self tune based on available system memory
  - Knowledge Base article KB438436
  - For MicroStrategy 2019, this is already set by default
Memory Settings: File Generation

- Maximum memory consumption:
  - XML
  - PDF files
  - Excel files
  - HTML files
Memory Settings: Result Caches

• Maximum RAM Usage
  • Least recently used cache is unloaded
  • Set high values for datasets and documents for fast end-user experience and to minimize swapping to disk

• RAM Swap multiplier
  • Set a multiplier to give additional cushioning while freeing up memory for cache loading

• Load caches on startup
  • Disable this setting to ensure Intelligence Server starts up quickly and with less memory footprint
Memory Settings: Dossier Caches

- Memory usage for dossier caches may be set through Workstation
  - Workstation setting is synchronized with the Developer setting

- Enable library and bookmark caching for improved performance when loading the dossier
  - Enable bookmark subscription caching to cache bookmarks as part of subscriptions
Memory Settings: Object and Element Caches

• Object cache
  • Reduce frequent queries to the metadata
  • Improve performance
  • Exists only in memory (no swapping to disk)
  • Recommend setting at least 4 GB

• Element cache
  • Improve element loading performance
  • Exists only in memory (no swapping to disk)
  • Recommend setting at least 1 GB
Memory Settings: Intelligent Cubes

• Maximum RAM Usage
  • Least recently used cube is unloaded
  • Plan to load enough cubes for faster performance and reduced disk swapping

• Load Intelligent Cubes on startup
  • Disable setting to ensure Intelligence Server starts up quickly

• Load Intelligent Cubes into Intelligence Server memory upon publication
  • Enable for fast end-user experience
Memory Settings: Result Sets

• Result Size
  • Final result rows, Intermediate result row
  • Affects the size of the result set retrieved and stored in Intelligence Server memory
  • Recommend setting finite values instead of -1

• Memory consumption during SQL generation and data fetching
  • Both are useful to restrict high memory usage
  • Recommend setting finite values instead of -1
## Clustering

<table>
<thead>
<tr>
<th>Setting</th>
<th>Benefit</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Cluster Maintenance Mode    | Keep the clustered resources in the surviving Intelligence Server cluster even if the node is shutdown normally | • [KB45399](#)  
• Enabled by default in MicroStrategy 2019 |
| Cluster Synch Check         | Deletes duplicate copies of Intelligent cubes as a consequence of maintenance mode | • [KB221178](#)  
• Enabled by default in MicroStrategy 2019 |
| Duplicate Cubes             |                                                                        |                                               |
| UseClusterSynchThread       | Increase threads to improve server responsiveness during high load conditions | • [KB240525](#)  
• Enabled by default in MicroStrategy 10.x/2019 |
| User Affinity Cluster       | Enable to minimize History List resource usage                         | • All sessions for a user are connected to the same node |
| Backup frequency            | Set it to 0 to prevent issues with cache and History list synchronization | • Value of 0 means cubes, caches and history lists are backed up as soon as they are created or updated |
Governors

Job

User

Memory

DB connectivity and execution
Result Sets (time)

- Result Sets (time)
  - Intelligence Server Elapsed Time
  - Warehouse execution time
  - Set a suitable finite value to prevent jobs from overloading Intelligence Server or the warehouse

- If reached, a “Cancel” signal will be issued for:
  - Intelligence Server job
  - SQLCancel ODBC call is issued if the job has been submitted to the database
Database Connections

• Connectivity and Execution
  • Maximum connection attempt time
  • Maximum query execution time
  • Set reasonable finite values to prevent connections and queries from overloading the Intelligence Server and warehouse

• Connection caching:
  • Connection lifetime
  • Connection idle timeout
  • Set reasonable finite values to balance:
    o Overhead associated with repeatedly connecting/disconnecting to the database versus,
    o Too many open connections taking up resources
Agenda

• Governing and Performance Tuning

• Performance Monitoring
  • Performance counters
  • KPIs

• Performance Analysis

• MicroStrategy 2019 Performance Improvements

• Enterprise Support
Performance Counters

• Performance counters - Windows
  • MicroStrategy Diagnostics and Performance Logging Tool
  • Windows Performance Monitor
  • Third-party tools (CloudWatch, SolarWinds, New Relic)
  • Statistics/Enterprise Manager

• Performance counters - Linux
  • MicroStrategy Diagnostics and Performance Logging Tool
  • Third-party tools (CloudWatch, SolarWinds, New Relic)
  • Statistics/Enterprise Manager
Performance Counters

Windows – **KB19154**

- MicroStrategy Server Jobs
- MicroStrategy Server Users
- Process (through *Windows Performance Monitor*)
  - % Processor Time
  - % User Time
  - Virtual Bytes
  - Private Bytes
  - Working Sets
- Processor (through *Windows Performance Monitor*)
  - % Processor Time (_Total)
  - % User Time (_Total)

Linux – **KB19155**

- MicroStrategy Server Jobs
- MicroStrategy Server Users
- Memory
- Process
  - % CPU Time
  - RSS (MB)
  - Size (MB)
- Processor
  - % System Time
  - % User Time
  - % Wait Time
  - % Idle Time
- System
  - RAM used
  - Swap used
  - Total CPU
Platform KPIs

- Users: 212 (+60.6% from 132)
- User Groups: 134 (+6.3% from 126)
- Total Projects: 5 (-0.0% from 5)
- Datasets: 292 (+45.3% from 201)
- Executions: 44,054 (-17.2% from 53,231)
- Objects: 1,059,279 (+44814.3% from 2,385)
- Successful Subscriptions: 2,408 (-29.2% from 3,399)
- Failed Subscriptions: 1,541 (-30.1% from 2,206)
## System KPIs

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
<th>Previous Day</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. CPU</td>
<td>1.11%</td>
<td>0.93%</td>
<td>+ 20.3%</td>
</tr>
<tr>
<td>Max CPU</td>
<td>15.60%</td>
<td>10.90%</td>
<td>+ 46.1%</td>
</tr>
<tr>
<td>Avg. Memory</td>
<td>30.17%</td>
<td>29.88%</td>
<td>+ 0.6%</td>
</tr>
<tr>
<td>Max Memory</td>
<td>44.60%</td>
<td>40.10%</td>
<td>+ 11.3%</td>
</tr>
<tr>
<td>Avail. Disk (GB)</td>
<td>25.32 GB</td>
<td>25.41 GB</td>
<td>- 0.4%</td>
</tr>
<tr>
<td>Disk I/O</td>
<td>0.38 Mbs</td>
<td>0.37 Mbs</td>
<td>+ 3.9%</td>
</tr>
<tr>
<td>Avg. Net In (Mbs)</td>
<td>2.63 Mbs</td>
<td>1.38 Mbs</td>
<td>+ 90.8%</td>
</tr>
<tr>
<td>Avg. Net Out (Mbs)</td>
<td>0.54 Mbs</td>
<td>0.51 Mbs</td>
<td>+ 6.0%</td>
</tr>
</tbody>
</table>
System KPIs: Memory and CPU Tracking

New Relic

CloudWatch
Agenda

• Governing and Performance Tuning

• Performance Monitoring

• **Performance Analysis**
  • CPU
  • Memory
  • Network
  • Physical Disk

• MicroStrategy 2019 Performance Improvements

• Enterprise Support
Performance Analysis: CPU

Processors (CPUs) on Intelligence Server machine frequently pegged at 100% or consistently running at high capacity (greater than 85%).

Actions to consider:

- Procure a faster processor
  - Enhances performance and reduces execution time
    - May need a new license key
- Increase number of processors
  - More capacity
  - Better load distribution
  - Overall performance gain
  - Better advantage of partitioning with Intelligent cubes (PRIME architecture)
    - May need a new license key
- Enable Hyper-Threading (Windows)/Simultaneous Multi-Threading (Linux)
  - Allows parallel processing
  - Disadvantage: Puts a slight overhead on execution time
Performance Analysis: Memory

Memory counters indicate that Intelligence Server is **consistently using a pre-defined threshold of the Operating System memory resources** (for example 85%)

**Actions to consider:**

- ✓ Tune Intelligence Server for optimal memory usage
  - ✓ Reduce initial memory footprint
  - ✓ Reduce complex SQL generation and Analytical Engine operations
  - ✓ Use minimum relations to join attributes ([KB303013](#))
  - ✓ Implement job/user/session governors
  - ✓ Implement cache and Intelligent cube governors
  - ✓ Implement file generation and result set governors

- ✓ Enable Memory Contract Management (MCM)
  - ✓ Minimum reserved memory for external processes
  - ✓ Single memory allocation governing
  - ✓ Working Set cache RAM
  - ✓ Smartheap tuning
Performance Analysis: Memory

Despite memory tuning and MCM:
- **Intelligence Server memory usage continues to be high**
- Operating close to the limits of physical RAM
- Significant memory contract request rejections

✓ Consider getting a more powerful machine (increased RAM)
✓ Cluster Intelligence Servers
Performance Analysis: Network

Network capacity utilization (network throughput as a percent of network bandwidth) is consistently greater than a pre-defined threshold (for example 80%)

**Actions to consider:**
- Increase network bandwidth
- Alleviate high network usage
  - Dataset and element caching
  - Incremental fetching of result sets
  - Data population for Intelligent cubes
- Decrease proximity between components to optimize network usage
  - Between Intelligence Server and Web/Mobile Server
  - Between Intelligence Server and metadata/warehouse
- Tune query engine to optimize data chunking and data retrieval across the network
Performance Analysis: Physical Disk

Physical disk utilization counters **consistently exceed pre-defined threshold** (for example 85%)
- Intelligence Server machine may not have enough memory (RAM)
- Operating system swaps memory in and out of page file on disk when RAM is full
- Performance will suffer

**Actions to consider:**
- Ensure governors that affect paging are optimally tuned
  - Maximum RAM usage for dataset cache
  - Maximum RAM usage for document cache
  - Maximum RAM usage for Intelligent cubes
- Defragment physical disk
- Increase physical RAM
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MicroStrategy 2019: Performance Improvements

MicroStrategy 2019 release benefits from the following major improvements

<table>
<thead>
<tr>
<th>Major Improvement</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory Contract Management (MCM) improvements</td>
<td>• Up to 45% concurrency throughput increase</td>
</tr>
<tr>
<td></td>
<td>• Up to 10% reduction in concurrent users response time</td>
</tr>
<tr>
<td>Windows Compiler upgrade</td>
<td>• Up to 58% concurrency throughput increase</td>
</tr>
<tr>
<td></td>
<td>• Up to 50% reduction in concurrent users response time</td>
</tr>
<tr>
<td>Linux Compiler upgrade</td>
<td>• Up to 17% concurrency throughput increase</td>
</tr>
<tr>
<td></td>
<td>• Up to 12% reduction in concurrent users response time</td>
</tr>
<tr>
<td>SmartHeap auto configuration</td>
<td>• Enabled by default in MicroStrategy 2019</td>
</tr>
</tbody>
</table>
MicroStrategy 2019: Performance Improvements

- MicroStrategy 2019 supports more active users as compared to MicroStrategy 10.4.8
  - 30% to 330% increase depending upon number of CPUs
MicroStrategy 2019: Performance Improvements

- MicroStrategy 2019 **consumes less CPU** for the same number of active users as compared to MicroStrategy 10.4.8
  - 20% - 25% less CPU consumption
MicroStrategy 2019: Performance Improvements

- MicroStrategy 2019 supports faster response times for the same number of active users as compared to MicroStrategy 10.4.8
  - 40% - 60% faster response times
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Platform Performance Advisory

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