Maximize Exadata Performance from SQL to Storage

Jagan R. Athreya
Senior Director, Product Management, Oracle
Safe Harbor Statement

The following is intended to outline our general product direction. It is intended for information purposes only, and may not be incorporated into any contract. It is not a commitment to deliver any material, code, or functionality, and should not be relied upon in making purchasing decisions. The development, release, and timing of any features or functionality described for Oracle’s products remains at the sole discretion of Oracle.
Exadata Database Machine
Performance, Availability and Security

Best Platform for Oracle Databases on-premises and in the Cloud

Enabled by:
• Single-vendor accountability
• Exclusive focus on databases
• Deep h/w and s/w integration
• Revolutionary approach to storage

Best for all Workloads
• Petabyte Warehouses
• Online Financial Trading
• Business Applications – SAP, Oracle, Siebel, PSFT, …
• Massive DB Consolidation
• Public SaaS Clouds
Exadata Deployment Models

**On-Premises**
- X7-2
- X7-8

**Cloud at Customer**
- Customer Data Center
  - Subscription
  - Oracle Managed

**Public Cloud Service**
- Oracle Cloud
  - Subscription
  - Oracle Managed
Optimize Resource Usage
- Which resources will the DB machine be bottlenecked based on current load growth from on-boarded databases?
- Which Exadata systems have available capacity headroom to support consolidation of additional databases?

Maximize SQL Performance
- For databases migrated to Exadata, which SQLs are performing better or worse than expected?
- Which of the poor SQLs regressed due to bad plans vs. excessive waits?
- Is the application performance suffering due to excessive non-CPU or non-I/O waits?

Troubleshoot Problems
- Which databases are reporting the most storage-related problems?
- How do I drilldown from the application tier to the Exadata database machine to perform RCA on my application?
Oracle Management Cloud: IT and Log Analytics for Exadata

- Global threat feeds
- Cloud access
- Identity
- Real users
- Synthetic users
- App metrics
- Transactions
- Server metrics
- Diagnostics logs
- Host metrics
- VM metrics
- Container metrics
- Configuration
- Compliance
- Tickets & Alerts
- Security & Network
- events

Comprehensive, Intelligent Management Platform
Zero-effort Operational Insights
Automated Preventative & Corrective Actions

Unified SaaS Platform
Application Performance Monitoring
Infrastructure Monitoring
Orchestration
Log Analytics
Configuration & Compliance
Security Monitoring & Analytics
IT Analytics
End User Experience / Activity
Application
Middle Tier
Data Tier
Virtualization Tier
Infrastructure Tier
Using Oracle Enterprise Manager with Oracle Management Cloud

**Oracle Enterprise Manager**

- Active **management** and deep **diagnostics** solution, highly tailored for Exadata and Oracle DB
- **Automates** critical DBA activity and increases DBA **efficiency**
- Collects Exadata metrics from EM repository and DB Metrics from AWR

**Oracle Management Cloud**

- Unified **big data** platform to provide deep **insights** across on-premise and on-cloud
- Automated metric collection from EM repository and AWR and log data collection across all Exadata DB machine components
- Extends collected data with **machine learning**
Agenda

1. Exadata Management Challenges
2. Optimize Resource Utilization
3. Maximize Database & SQL Performance
4. Troubleshoot Problems Rapidly
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Resource Utilization Challenges

Capacity Planning Challenges

- Pinpoint Exadata systems expected to run out of resources in the short & long term
  - Identify the top growing databases across the fleet
  - Identify the key resource (CPU, Memory, I/O or Storage) expected to run out and expected lead time to acquire additional capacity

- Uncover underutilized capacity and use available resources to onboard additional databases

Operational Challenges

- Unified view of inventory, availability, performance and log errors

- Identify DB Nodes that CPU or Memory bound
  - CPU bound when load average is high > runnable processes per core
  - Memory bound when memory utilization leading to swapping

- Storage cell performance issues
  - Storage cells approaching max performance capacity
  - Storage cell outliers
  - Flash Cache not used as expected
Exadata Analytics – Inventory & Capacity across Enterprise

- Fleet view of Exadata systems across the enterprise
  - By system type (Quarter, Half Rack)
  - Configured number of Exadata databases by database version

- Drilldown to single Exadata to view hardware and software components
  - Compute, storage and networking components
  - Inventory of databases and ASM components

- Aggregated view of total Exadata resources
  - Configured capacity vs. utilized capacity of CPU, Memory, I/O and Storage
Exadata Analytics – Forecast Capacity Growth vs. Headroom

• Single view of resource utilization across entire database fleet
  – Compute (CPU & Memory), Storage (ASM, Disk)
• Identify total lead time to expand capacity using machine learning based forecast
  – Project resource growth vs. configured capacity headroom
  – Use seasonality to identify growth patterns, e.g. weekly peaks vs. daily peaks
  – Classify Exadata systems based on available lead times 30, 60, 90, 180 days of capacity
• Get alerts on critical systems expected to hit capacity headroom in 30 days or less
Generating Capacity Alerts

• Collect configuration data on host and storage capacity for all Exadata systems
• Collect historical and current resource metrics for CPU, memory, I/O and storage
• Specify capacity headroom limit: Define operational capacity threshold such as 75% utilization for CPU, 90% for memory, the remaining is headroom i.e. buffer capacity
  – User can specify different capacity threshold per resource type, e.g. CPU, memory
• OMC uses machine learning algorithm to baseline and forecast capacity growth
  – Identifies weekly or yearly repeating resource patterns
  – Performs linear regression analysis to generate forecast
  – Detect regime changes (changes to workload, e.g. newly added database, that impact forecast)
• Plot forecast and estimate when resource usage will hit capacity headroom
• Generate alert if the lead time is 30 days or less
Exadata Dashboard: Storage Cells approaching IOPS & MBPS Limits

- Cells approaching max performance capacity for IOPS, one can look at
  - Small Read I/O per sec for Disk type = FlashDisk or Hard Disk and compare with Maximum Disk IOPS for Flash or Hard Disk
  - Small Read Throughput for Disk type = FlashDisk or Hard Disk and compare with Maximum Flash Disk MBPS for Flash or Physical Disk
Storage Cell Outliers

Identify cell outliers based on

- Throughput
  - Avg Large Read Throughput and Avg Small Read Throughput
- Response Time
  - Write Response Time and Read Response Time
- IOPS
  - Avg Small Read I/O and Avg Large Read I/O
- Flash Cache Space Usage
- Infiniband Network Traffic

Exadata Storage Cell Outliers Dashboard
Unified Exadata Monitoring: Roadmap

- Single estate view of all Exadata systems across the enterprise
  - Inventory, availability, capacity, performance
- Unify all aspects of monitoring, logs and analytics into a single console
- Drilldown to a single Exadata to explore these dimensions
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Which Database Performance Diagnostics Tool to Use?

**Automatic Workload Repository – AWR Reports**
- Reports about performance and workload data from AWR

**Active Session History – ASH**
- Gathers fine-grain data about every active database session every second

**Automatic Database Diagnostics Monitor - ADDM**
- Data Analysis and Problem Identification
- Findings and Advise on how best to resolve bottlenecks

**Real-time SQL and Database Operations Monitoring**
- Provides in-depth diagnostics about SQL execution at row source level
Database and SQL Performance Challenges

Database Performance Challenges

• Identify databases that are not taking full advantage of CPU or I/O due to poor application design or contention
• Identify database workloads that are degrading with growth or anomalous workloads that are showing degradation
• Identify unstable workloads that are showing a high degree of variability in performance

SQL Performance Challenges

• Identify SQLs whose response time is getting worse slowly over time
• Identify SQLs and associated databases contributing to high resource usage (CPU or I/O)
• Identify application SQLs that are a high degree of variability
  – Bad plans, high data growth, inconsistent behavior across test vs. production
Database Performance Analytics

• Analyze database performance based on long term performance data
• Get insights into database performance
  – Analyze performance degradation by response time
  – Identify inefficient databases by wait time
  – Analyze performance of high variant SQLs and databases
  – Databases which are increasingly inefficient
  – Top SQLs
Identify problem databases that needs attention

**Performance Degradation**
- Identify databases whose performance has degraded over time and is correlated with change in demand
- Identify negative correlations between performance trends and demand

**Variable Performance**
- Symptomatic of unpredictable workload and application response times
- Identify databases with high degree of variance in SQL response time

**Database Inefficiency**
- Database workloads where large % of the database time in spent in application waits (not on CPU or I/O)
- Not taking advantage of compute resources
- For example enq: TX – row lock contention, library cache lock
Performance Analytics: Drilldown to SQL Analytics for RCA

SQL Analytics

- Collect SQL, execution plan and session data into a long term SQL Warehouse
- Analyze SQL performance to find systemic root cause of SQL performance issues
  - High resource (CPU or I/O) consuming SQLs
  - Compare performance trends across databases, drill-down to execution plans for analysis
  - Compare current SQL response time vs. automatic baselines
  - Trends and forecast on SQL Response Time and other key SQL performance metrics
  - Was there a plan change of the SQL and compare plan to identify causes of SQL regression
## Identify problem SQLs and SQL Performance Insights that needs attention

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<thead>
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<tbody>
<tr>
<td><strong>Degrading SQL</strong></td>
<td>Response Time increases by more than 20% by linear regression</td>
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<tr>
<td><strong>Variant (unpredictable) SQLs</strong></td>
<td>Relative variability &gt; 1.66</td>
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<tr>
<td><strong>Inefficient SQL</strong></td>
<td>SQL with inefficiency &gt; 20% by linear regression</td>
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<tr>
<td><strong>SQLs with execution plan changes</strong></td>
<td>Execution plan hash value of the SQL changes</td>
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<tr>
<td><strong>Top SQLs by resource usage</strong></td>
<td>Consumes a disproportionate amount of system resources</td>
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<tr>
<td><strong>SQL Performance Insights</strong></td>
<td>Commonality and unique findings across enterprise wide SQL performance issues</td>
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Drilldown to Performance Metrics by Plan for specific SQL

- Trends by Active Session, Response Time, Executions
- What's the Inefficiency%?
- What are the Inefficient waits?

Get Trends of Individual SQLs
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Rapid Troubleshooting Challenges

• Aggregate log data from across all Exadata components across the enterprise
  – Database, Host, Listener, ASM and Storage server

• Search for common patterns in errors across Exadata components
  – Disk resilvering activity across storage servers or TNS connection timeouts observed by listener

• Identify problem component across the application stack
Log-based Troubleshooting

• Topology-aware log exploration and analytics
  – Search logs across database and storage infrastructure through visual analytic interface for
• Clustering, pattern, and outlier detection
  – Out of the box machine learning to group log patterns and identify outliers
• Proactive monitoring
  – Integrated with event system to notify on critical log errors
Why Log Analytics for Oracle Databases and Exadata Troubleshooting?

• Complement EM in troubleshooting and root-cause analysis

• Categories of problems in addition to performance issues
  – Database crashes, Connection failures, Delays in shipping archive logs
  – Backup/recovery failures, Runaway jobs, reports or ETLs, Patching/upgrade failures
  – Application upgrades and behavior changes
  – Credential changes

• Correlate logs across the DB, Exadata ecosystem
  – Database components: DB, listener, ASM, Clusterware, Storage cells, Infiniband, host...
  – Database infrastructure components: Host, VM, Database Firewall, Network & Storage components
  – Database ecosystem: Golden Gate, Backup/recovery, Reporting, ETL, Security etc.

• Correlate DB problem to other parts of the Application stack
Single-Touch Ingestion of Exadata and Database Logs

- Trace Logs
- ASM Logs
- Clusterware Logs
- Alert Logs
- Listener Logs
- OS
- Tables
- Audit
- Files
- Syslog
- Tables
- ExaWatcher
- OSWatcher
- Cell Alert Logs
- Custom
- Message Logs
- Secure Logs
Key Log Analytics Use Cases for Exadata Administrators

• **Centralized log collection**
  - Collect, aggregate, store logs from across all databases (single instance, RAC, ASM, Clusterware, Exadata)
  - Collect logs from files, databases, syslog, on-demand upload

• **Configuration log ingestion for all database logs**
  - Out-of-box log sources and parsers
  - Auto-associated with database entities, parameterized log location based on properties
Key Log Analytics Use Cases for Exadata Administrators

• Specialized ML algorithms enable smart clustering of log events based on common signature
  – How can I find unique log events?: Clustering log events to efficiently analyze large volumes of logs
  – Is my Database running new SQL statements after an upgrade?: SQL clustering

• Deep analytics on log events Linked by common attribute value(s)
  – Audit log object analysis – identify anomalies in database object access patterns, error conditions, SQL execution time
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Integrated Cloud
Applications & Platform Services