Proactive Performance Management for Enterprise Databases

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Abstract

DBAs today need to do more than react to performance issues; they must be proactive in their database management activities. Proactive management requires the right tools to help make sense of the overwhelming amount of raw data provided by the database engine. This paper explains the challenges involved in proactive database management and identifies the key features to look for in database management solutions.

The Database Performance Challenge

Becoming Proactive

All too often, managing performance is equated to resolving performance issues. While resolving problems is essential, the best database administrators (DBAs) do far more than merely react to trouble.

Proactivity is a popular objective for teams looking to improve the quality of their work and the stability of the systems they manage. In database management, becoming proactive is a challenge for three reasons:

- **Criticality** – Service levels are becoming more formalized as databases align with the applications they support, which reduces the tolerance for database downtime and poor performance.
- **Complexity** – The number of features to manage and metrics to understand increases substantially with each new database release. DBAs also face increased complexity from data volume growth and the fact that organizations are deploying databases at an ever-increasing rate[1].
- **Productivity** – DBAs are being required to manage more databases[2] and therefore are deploying more productivity tools to simplify and automate both routine tasks and the collection of performance data.

Setting Performance Objectives

To address these challenges, the most proactive DBAs set clear objectives about performance and the outcomes they seek. They also use high-quality data to make better decisions than experience alone can deliver, transforming raw performance metrics into meaningful, actionable information.

Four performance objectives repeatedly emerge, all of which extend far beyond simple problem response:

- **Accelerated problem resolution**. More urgent problems always need faster resolution. Proactive DBAs seek higher-quality alerts earlier in the problem lifecycle, immediate visibility into root causes, and options for automating recovery involving risky and time-consuming tasks.
- **Problem prevention**. Waiting for problems to strike is unacceptable. Proactive DBAs use historical data to recognize degrading performance conditions and determine how to prevent them from causing problems.
- **Maximizing hardware resources**. Increasing the efficiency of existing hardware provides direct savings; For example, deferring a hardware upgrade by just a few months can be significant. The optimization process also generally improves transaction throughput, making for happier users.
- **Reducing risk during change**. Changes are required when new application code is deployed into production or platform components are upgraded (hardware, OS, database). DBAs should have confidence that post-change performance will equal or exceed expectations. DBAs also need to anticipate workload changes and determine hardware break-points for applications that are subject to substantial volatility.

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[1] *Some enterprises that already have thousands of databases plan to grow their number of databases by 50% over the next five years. – Forrester Research, "DBMS Selection: Look Beyond Basic Functions," June 3, 2009*

[2] *Each DBA manages 35 databases on average. – Forrester Research, "Take Advantage of New Ways to Save Money on Database Costs," February 23, 2010*

Turning Data into Information

Database engines are equipped with performance metrics, and this data is the primary source for nearly all performance-related assessment. With every new release, the database provides more and more performance metrics. For example, Oracle 11g contains 1,100+ wait events, as compared to 870+ in 10g and 400+ in 9i.

Because so much data is available, DBAs simply cannot rely exclusively on raw metrics and be effective in meeting their performance objectives. In fact, none of the performance objectives listed can be achieved using the raw metrics provided by the database engine. Raw data can support a basic diagnostic process, but this relies heavily on the DBA's ability to interpret the data quickly and accurately. When complex problems are assessed using only raw metrics, decisions are driven more by guesswork than evidence. This increases the risk to the stability of the production system.

Proactive DBAs deploy performance technologies to automate the collection and most of the analysis needed to convert raw data into useful information. These technologies are categorized according to their core value and used in a simple process to help proactive DBAs meet their performance objectives, as illustrated here.

Monitor. Analyze. Optimize.

This approach is important in avoiding the situation where performance technology contributes more to complexity than to the understanding of performance.

Monitor	Detect unusual behavior and isolate the source
Analyze	Identify the root cause of performance bottlenecks; develop an optimization plan
Optimize	Restore and maximize performance
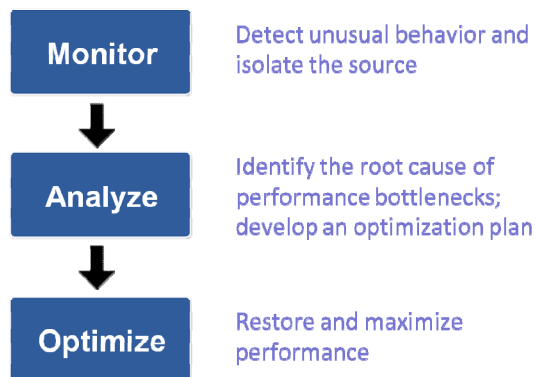
Assessing Performance Technologies

In assessing which technologies are most effective at improving the quality and stability of database performance, you have many capabilities to consider. This section examines the few vital factors that can make or break a technology deployment.

Three Levels of Performance Monitoring and Analysis

The inherent complexity of the database environment means that there are thousands of potential sources of poor performance, which is why automated monitoring and analysis is so desirable. A comprehensive technology embraces complexity by committing to measure all of the components that could potentially cause disruption to production performance. If it isn't measured, it isn't managed.

The DBA will need to define the scope of coverage required and verify this against the technology being assessed. There are three levels of performance monitoring and analysis relevant to the database:

- *Application performance monitoring (APM)* identifies problems within the components of the application, between end users and the database. Non-database modules may be relevant to the DBA, particularly virtualization monitoring components.
- *Instance monitoring* identifies problems affecting the database infrastructure, providing early warning about stressed configuration or components that can affect the user experience.
- *Transaction workload analysis* measures the SQL that connects users and applications to database resources. Deep visibility into database transactions is essential for critical databases because it enables the DBA to prioritize high-impact sources for resolution, prevention and optimization.

Application Performance Monitoring

APM ensures application service delivery meets business and end user needs. It must provide a correlated, 360° view of managed applications, from end user to database and from service levels to infrastructure – to source the root cause of every incident impacting the business and to fix them quickly.

The database is the most critical component in the application stack. Besides containing the data that runs the business that the application is servicing, the database is the focal-point of every transaction. A slow database impacts all users and application processes. Maximum continuous performance for the application requires that the instance, transaction workload, operating system and virtual machines supporting the database are all optimized.

Instance Monitoring

Instance monitoring is a foundation of effective database management because it provides the DBA with visibility into the performance of every database in the organization. The following aspects of instance monitoring are important in assessing a technology:

- Accelerated problem resolution
- Intelligent alerting and baseline analysis
- Production independence

Accelerated Problem Resolution

An intuitive user interface is important in seeing all managed databases in a single console. This console enables the DBA to quickly isolate and investigate a particular database as soon as it experiences a problem. The whole workflow, from console to problem source, should be completed in a few clicks of the mouse.

Intelligent Alerting and Baseline Analysis

When a problem is current or imminent, the DBA requires clear direction to quickly minimize or avoid user impact. The DBA gains a real advantage when alerts are accurate, provide early warning, and help prioritize concurrent issues by the severity of their impact.

Fixed thresholds are useful for identifying critical conditions, but they provide only a short warning period for the DBA to deal with problems before users are affected. Adjusting the sensitivity of thresholds provides warning alerts earlier in the problem cycle, but also creates many false alarms, increasing administrative overhead.
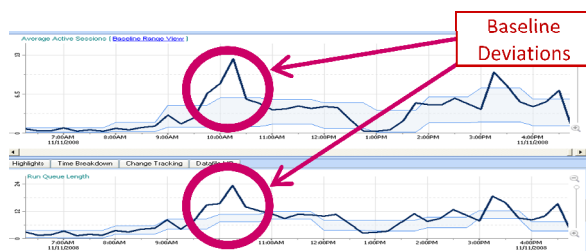
Correlation between workload performance and server run queue

Baseline analysis addresses this weakness by using historical data to build performance profiles for each collected metric. The DBA receives a warning when baseline deviations occur, and the alerts are both highly accurate and timely, occurring before the problem has progressed enough to affect users.

Production Independence

Performance metrics must be managed and stored away from the production server to eliminate the risk associated with a single point of failure. Embedded performance data is prone to the same problems that affect users, often preventing the DBA from accessing performance data when it is most urgent.

Transaction Workload Analysis

The third level of performance monitoring and analysis is transaction workload analysis. Because of the highly dynamic nature of the transaction workload, measurement requires specialized technology. When assessing a workload analysis solution, be sure to consider all of these factors:

- Context
- Problem prevention
- Data granularity
- Measured overhead
- Scalability and integrity

Context

Comprehensive analysis of the transaction workload requires context. Database transactions constantly interact with complex subsystems (such as OS, configuration, and I/O), so the collected data must measure the performance of all of these subsystems, and the data must be correlated into a meaningful, actionable format.

Products that present wait states are not conducting workload analysis. Wait states provide valuable information about where a database is spending time, but not why. Nor do they describe how contention affects users, leading to tuning efforts that solve symptoms rather than root causes.

Also important is the concept of directed workflow—where a product drives the DBA towards a deeper understanding of the underlying performance condition. Severity, advice and cross-linked analysis are critical in accelerating an awareness of the context of a performance problem and its root cause.
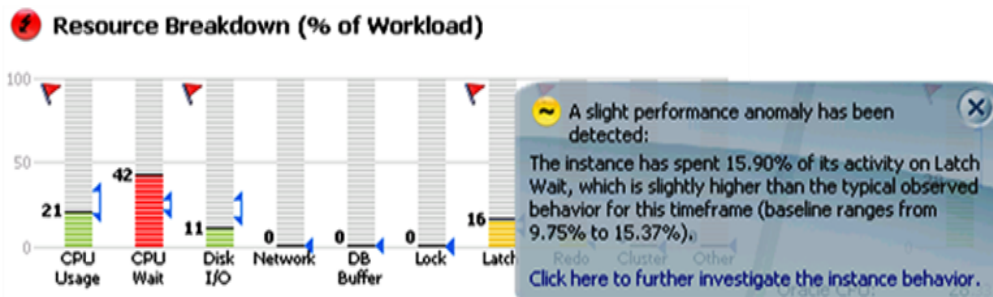
Color-coded alerts indicate severity and link directly to advisories and dimensional analysis

Problem Prevention

The ability to prevent problems is a decisive factor in helping DBAs become proactive. Typically, problems start a long time before they affect users. But they escape detection until they suddenly become critical—when it's often too late to avoid the impact.

Advanced administrators constantly look for sources of potential slowdown. They need to know when critical processes (or the entire workload) are degrading so they can take corrective action. Comparing recent performance with historical data (or a baseline generated from that historical data) is a fast and effective way to identify degrading trends.
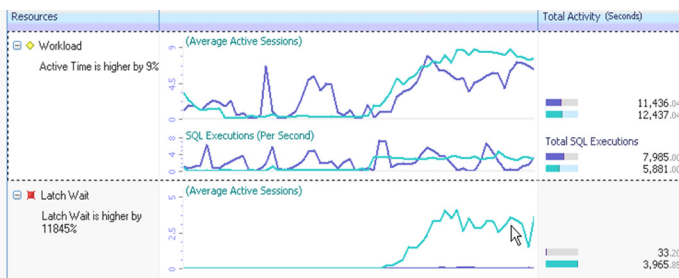
Significant trends are identified early, before they impact users

Data Granularity

Effective transaction workload analysis requires that the data feeding the analysis engine is of the highest quality. Low granularity data introduces a significant margin of error, which is unacceptable for accurately managing the performance of critical databases. Data granularity is determined by the frequency of collection.

Database transactions can switch context several times per second, and even a moderate transaction volume will run dozens or hundreds of new SQL statements every second. A sub-second collection rate is an important requirement for managing critical databases: the collection frequency must exceed the rate of volatility within the transaction sub-system to guarantee accuracy.

Example: In assessing one minute of performance, a collection frequency of 100Hz will provide 6,000 samples of each metric for analysis, compared to 60 samples with a 1Hz frequency.

It is important that the collection rate adapts to the user workload; that is, it must increase in frequency to maintain maximum data quality at peak loads, and decrease when the workload slows to preserve resources. Static collection frequencies reduce accuracy during high-load periods, because as transaction volume increases during peak periods, data granularity decreases and significant gaps appear in the data.

Measured Overhead

Optimized collection aims to provide the highest quality data at the lowest cost. A product should include visibility into its own overhead on production resources, for two primary reasons:

- Any claimed collection cost needs to be verified in a production environment to ensure that it aligns with the actual, observed overhead. If it isn't reported, it cannot be measured.
- Performance monitoring always incurs some resource overhead, which becomes a part of the production workload. It needs to be managed no differently, as a potential source of contention.

Scalability and Integrity

Many technologies appear to work under moderate workloads. The issues with monitoring start to surface only as usage grows and the number of databases and transactions grows with it.

Example: When databases are under pressure, the collection of performance metrics using SQL calls could fail because the affected database (production) is not accessible. This failure creates holes in the performance data when it is most needed—when the problem occurred—hindering problem investigation.

Externalized collection is independent of any currently occurring database problems, and has zero impact on in-database resources. Collection occurs without interruption during periods of peak load, and access to the performance data is fast and available at all times.

Conclusion

The complexity and criticality of modern enterprise databases necessitate advanced approaches for DBAs to become proactive in the way they manage performance. The volume of raw performance data provided by the database has increased beyond the point where it is useful without meaningful analysis.

Proactive DBAs rely on specialist technology to continuously monitor and analyze database performance, providing high quality, decision-ready information that eliminates guesswork from the assessment process. Technology is also deployed to automate complex optimization tasks and to help DBAs meet specific performance objectives:

- Accelerated problem resolution
- Problem prevention
- Maximizing hardware resources
- Reducing risk during change

About the Author

Dave Pearson is a senior product manager at Quest Software, where he focuses on Oracle performance management products. He has been with Quest since 1999, and has 20 years of experience working with relational database systems and the applications that use them.

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