



# IBM DB2 Performance Solution Pack for z/OS Overview

*Version 1 Release 3*





# IBM DB2 Performance Solution Pack for z/OS Overview

*Version 1 Release 3*

**Note:**

Before using this information and the product it supports, read the "Notices" topic at the end of this information.

**First Edition (June 2015)**

This edition applies to Version 1 Release 3 of IBM DB2 Performance Solution Pack for z/OS (product number 5655-E74) and to all subsequent releases and modifications until otherwise indicated in new editions.

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## About this information

IBM DB2 Performance Solution Pack for z/OS, Version 1 Release 3 combines several IBM components into a consolidated solution that uses powerful DB2 tools to identify, diagnose, solve, and prevent performance problems on DB2 for z/OS on an enterprise scale.

IBM DB2 Performance Solution Pack for z/OS contains the following components:

- IBM DB2 Query Monitor Version 3.2
- IBM DB2 SQL Performance Analyzer for z/OS Version 4.2
- Tivoli OMEGAMON XE for DB2 Performance Expert on z/OS Version 5.3
- IBM InfoSphere Optim Query Workload Tuner Version 4.1

The topics in this Guide provide an overview of the components and capabilities that are delivered with IBM DB2 Performance Solution Pack for z/OS and some common usage scenarios to help you understand the capabilities of the product. These topics also provide comprehensive instructions for customizing the solution pack after a successful SMP/E installation.

These topics are designed to help database administrators, system programmers, application programmers, and system operators perform the following tasks:

- Understand the capabilities of the functions that are associated with the solution pack
- Perform the pre-customization tasks for the components
- Customize the components of the solution pack
- Troubleshoot any errors that might occur during the customization process

To use the functions that are described in this information, you must have already installed IBM DB2 Performance Solution Pack for z/OS by completing the SMP/E installation process that is documented in the program directory for IBM DB2 Performance Solution Pack for z/OS, GI10-8840-02.

To use these topics, you should have a working knowledge of:

- The z/OS operating system
- ISPF

Always check the DB2 Tools Product Documentation page for the most current version of this information:

<http://www.ibm.com/software/data/db2imstools/db2tools-library.html>





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## Chapter 1. IBM DB2 Performance Solution Pack for z/OS overview

IBM® DB2® Performance Solution Pack for z/OS® (also referred to as DB2 Performance Solution Pack) combines powerful DB2 tools that identify, diagnose, solve, and prevent DB2 for z/OS performance issues on an enterprise scale.

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### What is DB2 Performance Solution Pack for z/OS?

DB2 Performance Solution Pack is a set of functionally compatible components that optimize the performance of DB2 for z/OS by monitoring, analyzing, and tuning all major aspects of system performance. The solution delivers expert advice that takes the guesswork out of identifying, diagnosing, and fixing performance problems.

DB2 Performance Solution Pack is an integrated solution that supports a comprehensive and holistic approach to managing performance. The integration between monitoring and tuning functions minimizes resolution time in the most complex DB2 environments. If you currently rely on the skills of individual experts to resolve performance issues manually, you are vulnerable to *single point of failure* scenarios. DB2 Performance Solution Pack helps you to avoid these types of performance issues by providing expert diagnosis and tuning capabilities to all members of your technical staff, even those with minimal experience.

DB2 Performance Solution Pack consists of the following product components:

- Tivoli® OMEGAMON® XE for DB2 Performance Expert on z/OS (also referred to as OMEGAMON XE for DB2 Performance Expert)
- IBM DB2 Query Monitor for z/OS (also referred to as DB2 Query Monitor)
- IBM DB2 SQL Performance Analyzer for z/OS (also referred to as DB2 SQL Performance Analyzer)
- IBM InfoSphere® Optim™ Query Workload Tuner for z/OS (also referred to as Optim Query Workload Tuner)

### OMEGAMON XE for DB2 Performance Expert

OMEGAMON XE for DB2 Performance Expert is a full-featured performance monitoring, analysis, and tuning tool.

#### Monitoring

The system and application monitoring features provide an end-to-end view of performance in the z/OS environment as a whole, both inside and outside of DB2. These monitoring features enable you to perform the following functions:

- Analyze performance problems in the DB2 subsystem and the application
- Collect historical data to identify performance trends over time
- Review near-term historical data for performance analysis
- Understand and tune buffer pools
- Run application traces to identify potential performance issues

- Drill down into the dynamic statement cache to identify poorly performing dynamic SQL
- Generate performance reports for trend analysis and historical insight into applications
- Create exceptions specific to your environment and highlight them as they occur
- Report on exceptions

When performance is lagging, the DBA is typically the first person to be notified. But the bottlenecks are not always in the database. The integrated performance management features in OMEGAMON XE for DB2 Performance Expert provide a comprehensive real-time view into *all* system components, including the server, the network, and the application. Executives, managers, and members of your IT staff can log on to the web console and see for themselves where the bottlenecks really are.

These examples describe some of the available monitoring features:

- Structured query language (SQL) monitoring
- SQL cache monitoring
- Stored procedure monitoring
- Buffer pool monitoring

### **Analysis and tuning**

You can use OMEGAMON XE for DB2 Performance Expert to analyze application and system problems while your production system is running. You can use one or more of the following components to analyze and identify bottlenecks or other performance problems:

- Classic 3270 interface  
The Classic Interface analyzes problems in a fast and reliable VTAM<sup>®</sup> interface, and can share SQL statement text with DB2 SQL Performance Analyzer for tuning. You can monitor and solve DB2 problems when the LPAR or the TSO login is unavailable.
- OMEGAMON enhanced 3270 user interface  
The enhanced 3270 user interface offers predefined and user-defined workspaces that make it quick and easy to diagnose problems and take corrective action.
- Web-based interfaces

#### **Java-based interface**

This optional interface, which uses a Tivoli Enterprise Portal (TEP) plugin, provides information similar to that which is provided by the Performance Expert Client and Classic Interface.

#### **Web console**

The web console provides *Extended Insight*, sometimes called *end-to-end SQL monitoring*, which enables you to monitor the performance of your entire database application environment on z/OS. The web console also provides health monitoring, static and dynamic SQL monitoring, and stored procedure monitoring.

The web console can share information about individual queries, transactions, and user-defined workloads with Optim Query

Workload Tuner for more analysis and tuning. You can invoke the web console as a workspace in Tivoli Enterprise Portal or in a separate browser session.

**Note:** You do not have to license additional products to use these features. IBM delivers the required technology with OMEGAMON XE for DB2 Performance Expert. The optional TEP plugin can be used together with a separately-licensed product, IBM InfoSphere Optim Performance Manager for Linux, UNIX, and Windows. The underlying technology of *end-to-end SQL monitoring* or *Extended Insight* is also available in IBM InfoSphere Optim Performance Manager.

- Performance Expert Client

This graphical user interface runs on the Windows operating system. Performance Expert Client can analyze the entire database management system (DBMS) or a single application.

You can collect and evaluate historical data in a performance database, which is useful for tuning, problem analysis, trend analysis, and capacity planning. A performance warehouse automates these processes for you.

You can tune buffer pools by using Buffer Pool Analyzer, a suite of functions that monitor, analyze, and simulate buffer pools. Buffer Pool Analyzer also provides recommendations about how to optimize your queries.

OMEGAMON XE for DB2 Performance Expert also includes reporting features that deliver performance information at any level of detail that your business requires. You can identify and analyze performance trends over time by using a performance warehouse that stores historical data.

For more information about OMEGAMON XE for DB2 Performance Expert concepts, see Product overview.

## DB2 Query Monitor

DB2 Query Monitor is a dedicated, low-overhead SQL monitoring tool that enables you to perform the following performance management activities:

- Identify problematic SQL activity by using a simple but powerful data navigation facility that helps you to explore SQL activity by plan, package, user, SQL statement, and more.
- Investigate a rich set of metrics that show how tables and indexes are used by plans, programs, users, and SQL statements.
- Identify the contexts in which any SQL statement is used.
- Display current and historical views of query details in all monitored DB2 subsystems.
- Detect SQL processing that threatens to overrun the system, with options to issue notifications or terminate queries automatically.
- Reduce troubleshooting costs by finding the cause of delayed SQL queries in real time.
- View extensive detail of exceptional processing of individual SQL statements, such as runs that exceed a processor threshold.  
The detail includes host variables, call-level metrics, and detailed metrics on object usage for the specific run.
- View details by individual DB2 subsystems, or by the entire data sharing group.

- View current metrics for all SQL statements that are currently active in any monitored DB2 subsystem, including stacked calls within the same thread.
- View summaries and detail for negative SQL codes that occur in monitored DB2 subsystems.
- View all DB2 commands that are issued in all monitored DB2 subsystems.
- Export all data in DB2 Query Monitor to a DB2 subsystem for further analysis, reporting, and archiving by using the DB2 offload facility.

You can explore the data that DB2 Query Monitor collects by using both an ISPF interface and a web interface. The web interface offers the ability to explore offloaded data in the same interface as current data.

For more information about DB2 Query Monitor concepts, see DB2 Query Monitor overview.

## DB2 SQL Performance Analyzer

DB2 SQL Performance Analyzer is an SQL performance analysis tool for organizations and IT staff who prefer an ISPF interface. It is the tool of choice for application developers who want to analyze one query at a time.

IBM Tools Customizer simplifies the customization of DB2 SQL Performance Analyzer. It provides a standard interface and methodology for both initial and subsequent customizations.

You can use the following features in DB2 SQL Performance Analyzer to optimize your SQL queries:

- Over 150 predefined performance *rules-of-thumb* that help you to quickly identify performance problems
- *What if* analysis that provides performance estimates based on hypothetical optimization strategies  
DB2 SQL Performance Analyzer uses DB2 EXPLAIN data and cost estimate features to access system data, including environment variables and DB2 catalog information.
- A built-in *governor* function to prevent expensive SQL from running
- An advisor function that provides performance hints
- ISPF and batch reports

For more information about DB2 SQL Performance Analyzer concepts, see DB2 SQL PA overview.

## Optim Query Workload Tuner

For organizations and individuals who prefer graphical user interfaces (GUIs), Optim Query Workload Tuner optimizes both individual queries and query workloads in an Eclipse-based environment. IT staff of all levels of experience can use this tool to reduce complexity and minimize the manual effort that is required for analysis and tuning.

Optim Query Workload Tuner also provides expert, actionable advice to improve performance. You can use it to generate recommendations automatically by processing query information in expert advisors. The following examples describe some of the potential uses:

- Capture statistics for improved access path selection
- Optimize access path selection  
Optim Query Workload Tuner supports *query annotation*, a feature that helps you with query analysis by providing vital statistical information directly in the SQL statement.
- Perform *what if* analysis for adding or dropping indexes  
You can change index statistics and then check whether the optimizer chooses the index.
- Create, validate, and deploy plan hints to modify access plans directly
- Get recommendations that help you to rewrite queries for increased efficiency
- Add new indexes or remove unused ones to reduce database scans and avoid unnecessary processing

For more information about Optim Query Workload Tuner concepts, see Overview of IBM InfoSphere Optim Query Workload Tuner.

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## Benefits

The enterprise-scale performance management tools in DB2 Performance Solution Pack can provide measurable savings to your business, including reduced capital expenditures, consistent service level attainment, increased productivity, and customer satisfaction.

### Savings

#### Reduced capital expenditures

DB2 Performance Solution Pack accommodates growth by using existing resources more effectively. The lack of an effective performance management solution often causes organizations to invest capital that could be put to better use elsewhere. They are either forced to purchase more server processors, memory, and disk storage than they really need, or they are forced to devote costly staff time to research and resolve performance problems.

#### Service level attainment

High-performing databases and applications enable your business to meet its service level agreements (SLAs). As custom and packaged applications make increasing demands on databases, poor system performance can result in costly penalties in the form of unfilled orders, reductions of service, and revenue loss.

#### Increased productivity

Good performance management increases employee productivity. When information management systems are unavailable, business users abandon the slow system and change tasks, adding unproductive churn. On an enterprise scale, the tiniest percentage of increased productivity can add up to millions of dollars in savings each year.

#### Customer satisfaction

To maintain customer satisfaction and loyalty in today's business climate, information systems must be available and responsive. A customer who waits for minutes instead of seconds for an ATM machine to display an account balance is a frustrated customer. Unresponsive customer-facing applications can lead to dissatisfaction and lost revenue.

## Capabilities

DB2 Performance Solution Pack provides the end-to-end features that your enterprise requires to move from a reactive model of performance management to a proactive one. It delivers a comprehensive approach to performance management that is built upon the following aspects of problem resolution and prevention:

1. **Identify**
2. **Diagnose**
3. **Solve**
4. **Prevent**

### Identify

The first step in resolving a performance problem is to identify the source of the problem. You also have to determine whether the event is an isolated incident or an ongoing problem. To identify performance issues quickly, performance management strategies must include 24x7 monitoring, proactive notifications, and automated alerts.

OMEGAMON XE for DB2 Performance Expert identifies performance problems across the entire DB2 and z/OS environment, and DB2 Query Monitor identifies poorly performing SQL.

#### **Use OMEGAMON XE for DB2 Performance Expert to monitor the performance of all system components**

This powerful tool offers the following features to help you identify performance issues:

- A full range of system and application monitors for viewing performance data
- An integrated real-time monitor with zoom capabilities that can access any level of detail that your business requires
- Extended insight into the performance of distributed applications that access data on DB2 for z/OS

To effectively identify performance issues, an end-to-end solution requires both transaction and SQL monitoring. You can monitor your DB2 environment continuously or on a periodic basis. You can flag exceptions and issue proactive notifications when performance falls below user-defined thresholds.

OMEGAMON XE for DB2 Performance Expert provides 24x7 monitoring of the entire DB2 and z/OS environment, and can display the following views in real time:

- Performance data
- z/OS system statistics
- Currently running applications and concurrency problems
- DB2 system configuration parameters
- The contents of the dynamic and static SQL statement cache

Although less-than-optimum SQL represents 80 - 90 percent of performance problems, OMEGAMON XE for DB2 Performance Expert provides comprehensive information about the performance of the *entire* environment. The following examples describe potential bottlenecks that OMEGAMON XE for DB2 Performance Expert can help you identify:

- Activities and statistics in the logical partition (LPAR) on z/OS, such as enclave information from the workload manager (WLM)
- SQL statements
- Transaction processing activities in the DB2 subsystem, such as volume allocation, units of work, writer threads, statistics, and the dynamic statement cache
 

Multiple units of work can operate in a single thread. OMEGAMON XE for DB2 Performance Expert monitors thread pools, deadlocks, and memory pools.
- DB2 system configuration parameters
- Locking conflicts
- Application activity
- Activities in the network layer, including TCP/IP performance
- Activities in DB2 gateways that use DB2 Connect™
- Web server activity
- Buffer pools
- Utilities

### **Use DB2 Query Monitor to monitor the performance of queries and the applications that use them**

DB2 Query Monitor provides 24x7 monitoring of SQL activities across all participating DB2 subsystems in a data sharing environment.

This full-featured tool makes it easy to perform the following essential monitoring functions:

- Identify problematic queries in the browser interface of the Consolidation and Analysis Engine (CAE)
 

DB2 Query Monitor helps you to identify the applications that use a particular SQL statement.
- Drill down for details about query performance
- Send the SQL text of the most expensive queries to Optim Query Workload Tuner or DB2 SQL Performance Analyzer for more analysis and tuning

DB2 Query Monitor identifies queries that put excessive demands on DB2 and affect the performance of other running applications. You can produce alerts when queries cross thresholds that you define, such as processor or getpage thresholds. DB2 Query Monitor shows you information about the SQL to help you identify the source of the offending SQL.

### **Use DB2 Query Monitor to automate responses to performance issues**

You can configure monitoring profiles in DB2 Query Monitor to define actions that are based on user-defined performance thresholds. DB2 Query Monitor can take corrective actions automatically, including the following types of actions:

- Sending proactive email notifications and alerts
- Running command scripts
- Issuing write-to-operator (WTO) messages
- Making configuration changes
- Canceling threads
- Initiating SNMPv1 and SNMPv2 traps



## Diagnose

After you identify the problem, the next step is to diagnose it. DB2 Performance Solution Pack simplifies the collection of diagnostic information for technical staff of any level of experience. It evaluates complex application infrastructures and their multiple technology layers to find the links between applications and the SQL that runs in the database. You can determine the precise location where a transaction is spending too much time, and you can analyze the root causes of poor performance, such as resource shortages or exceptional conditions.

The Extended Insight features in OMEGAMON XE for DB2 Performance Expert measure elapsed time for every step in a transaction, including key indicators for distributed applications. You can evaluate workload response time per user, and review how much time a transaction spends in each of the following areas of the application:

- DB2
- The application program in the application server
- The network

DB2 Query Monitor provides rich diagnostic capabilities that determine root causes of performance issues that are related to SQL and application processing. DB2 SQL Performance Analyzer optimizes the performance of SQL statements without having to run the SQL in production. Optim Query Workload Tuner optimizes SQL performance in an IBM Eclipse interface.

### Collect key performance indicators (KPIs)

You can configure the Extended Insight features of OMEGAMON XE for DB2 Performance Expert to collect all relevant KPIs and make them available from any location. With 24x7 access to these KPIs, you no longer have to rely on manual processes to collect diagnostic information.

### Perform trend analysis

If monitoring operations flag a transaction that is taking many times longer than expected, you can perform trend analysis to determine which system components are affecting transaction response times.

OMEGAMON XE for DB2 Performance Expert has a Performance Database and Performance Warehouse that store detailed historical information about performance. You can collect information from many different sources, including System Management Facilities (SMF), the generalized trace facility (GTF), and the OMEGAMON Collector. *Rules of thumb* (ROT) analysis enables you to create formulas against columns in the performance warehouse for analysis. For example, you can find all packages that consumed more than .5 seconds of processor time.

In addition to identifying top performance offenders, DB2 Query Monitor can also analyze historical data to flag applications or statements that show the greatest incremental increases in run time. Automated notifications inform you about any sudden spikes that are inconsistent with previous trends.

### Collect real-time snapshot data

OMEGAMON XE for DB2 Performance Expert can start synchronous traces that collect detailed performance data. You can collect almost any relevant information, including concurrent running threads, and generate real-time alerts.



## Collect event trace data

OMEGAMON XE for DB2 Performance Expert can also start asynchronous traces to gather more details about the following types of events:

- Start and end of paired events, such as SQL, SCAN, I/O, and lock waits
- End of thread events
- Timeouts and deadlocks
- Statistics intervals

## Make insightful comparisons

Features available in Optim Query Workload Tuner make it easy for anyone to review the following types of comparisons, regardless of skill level:

- Statistical results of different access plans in diagram format
- Available actions
- Differences between table joins
- Differences between table access and operations
- Differences in PLAN\_TABLE records

## Indexes

Some performance problems call for adding one or more indexes. However, unused or obsolete indexes also impede performance. With the *virtual drop* capabilities that are built into Optim Query Workload Tuner, you can easily remove unnecessary indexes from the database.

## Solve

A performance challenge usually has many possible solutions, and it is not always obvious which one is best. One SQL statement or user identifier in isolation cannot provide a complete picture. If you apply an improvement strategy that worked for one SQL statement to a different type of statement, it might not produce the same results.

Expert advice that is provided by OMEGAMON XE for DB2 Performance Expert helps you to resolve problems quickly, regardless of experience. DB2 Query Monitor monitors running queries, query workloads, and DB2 objects, and then sends data to other components for analysis and tuning. DB2 SQL Performance Analyzer generates expert advice in an ISPF interface to optimize the performance of SQL statements and applications. Expert advice features in Optim Query Workload Tuner also optimize queries and query workloads.

## Generate expert advice automatically

DB2 Performance Solution Pack delivers the information that you need to optimize performance quickly.

The following examples demonstrate some of the potential performance bottlenecks for which you can retrieve expert advice automatically:

- I/O access  
Bottlenecks at the I/O level indicate problems with indexing or access methods.
- Processor consumption
- Network throughput

You can use the advisors and comparison capabilities in Optim Query Workload Tuner to optimize query design, statistics quality, and index value.

The following examples demonstrate how expert advisors can improve performance:

- Satisfy queries without reading the data rows at all.
- Improve index value by creating and consolidating indexes to reduce scans and avoid sorts.
- Improve query design by recommending an additional predicate that selects a different index.
- Improve the quality of your statistics by identifying the ones that are missing or out of date.
- Generate a statistics profile based on an analysis of your query workload and then insert the profile in the DB2 Statistics Profile table for the use of DB2 *auto stats*.

### Analyze tradeoffs at the workload level

Unlike other performance management tools, DB2 Performance Solution Pack can analyze entire workloads. A workload might contain thousands of SQL statements, and you cannot get a complete picture by analyzing each statement in isolation. DB2 Performance Solution Pack identifies an optimal strategy by balancing competing concerns across the entire application.

The following examples demonstrate some of the tradeoffs that DB2 Performance Solution Pack evaluates to optimize a workload:

- When you collect more statistics, you increase processor cost.
- You can increase speed by adding indexes to a query, but doing so introduces delays in transaction processing.
- A performance improvement strategy for one SQL statement in an application can deprecate performance for other statements.

### Prevent

If you can tune queries and workloads proactively, you can address performance problems before they occur. However, a proactive approach often requires senior DBAs to devote large amounts of their time, which is a luxury that many organizations cannot afford. Without access to costly professional skills, you cannot conduct adequate reviews of SQL performance and the physical design of the database before deployment. Senior DBAs are typically busy with more urgent priorities than query optimization or preventive measures, which leaves them little time to address the large volume of SQL in a workload.

An effective prevention strategy goes beyond addressing performance problems that you are already aware of. You must also be able to analyze and understand trends that might not be obvious. Performance databases in DB2 Performance Solution Pack provide a historical view that gives you the following advantages:

- A deeper understanding of baseline performance levels that you can use to measure current performance
- The ability to analyze historical performance information during heavy workload periods
- The ability to evaluate whether a proposed performance enhancement has unintended consequences or it yields a true net benefit

- Perspective on areas that consistently present problems over time

### **Store performance data for analysis and reporting**

OMEGAMON XE for DB2 Performance Expert reduces total cost of ownership by supporting background processing with zIIP technology to minimize the cost of collecting performance statistics and other historical data. You can store trace data in a performance database to help you analyze performance issues over time, and deploy a Performance Warehouse to automate processing and reporting.

### **Generate meaningful reports**

By using DB2 Performance Solution Pack, you can produce reports to any level of detail that your organization requires, from raw data to summaries per time interval. The information that reports provide helps you to make strategic decisions about costly processor consumption. Batch reports that are based on trace-level information identify performance issues wherever they occur, and in many cases, before they occur. Reports help you to analyze, simulate, and optimize buffer pool activity, which further reduces total cost of ownership. All of this data is critical input to defining an effective prevention strategy.

DB2 Performance Solution Pack supports capacity planning by providing a full range of formats for analyzing performance data. The following examples show some of the report formats that you can use to present performance-related information:

- Charts
- Pivot tables
- Statistical summaries
- Accounting reports that describe TOP issues  
For example, you can report the top 50 packages that use the most processing cycles, or the top 50 packages that take the longest to run.
- Detailed lock and latch reports that help you to resolve locking issues
- Exception reporting
- Reports that help you to review potentially problematic queries before promoting your application to a production system

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## **Integrated performance management in a single solution**

All the components of DB2 Performance Solution Pack interact with one another to provide a comprehensive performance management solution.

### **Retrieve performance data across all DB2 and z/OS components**

Optim Query Workload Tuner or DB2 Query Monitor can determine whether performance issues at the query level are related to static SQL, dynamic SQL, or stored procedures. OMEGAMON XE for DB2 Performance Expert can determine whether the bottleneck is in an application server, web server, DB2 for z/OS, query processing, or the network.

### **Capture queries and workloads for monitoring**

DB2 Performance Solution Pack can capture queries and workloads from any of the following sources:

- OMEGAMON XE for DB2 Performance Expert repository
- DB2 Query Monitor (interval data sets or offload repository)

- Optim Query Workload Tuner (offline repository)
- Database request modules (DBRMs)
- Flat files
- DB2 packages
- Caches
- Stored procedures

From the Workflow Assistant in Optim Query Workload Tuner, you can capture a query workload from the repository in OMEGAMON XE for DB2 Performance Expert. You can then share the workload on a bidirectional connection with the end-to-end SQL monitoring functions in Extended Insight.

## **Tune SQL statements in context**

### **Reactive tuning**

From the web-based interfaces of DB2 Query Monitor or OMEGAMON XE for DB2 Performance Expert, you can perform reactive tuning that identifies problem SQL, query workloads, or runtime metrics while your applications are running. You can then start Optim Query Workload Tuner automatically for analysis and tuning recommendations.

### **Proactive tuning**

DB2 Query Monitor can also be a source of query workload data for capture and proactive tuning. This workload data includes the metrics that you need to tune your SQL statements, including execution counts and the current schema.

If you prefer to work in an ISPF interface, you can isolate an inefficient SQL statement in the ISPF interface of DB2 Query Monitor and start DB2 SQL Performance Analyzer for tuning. Expert advice then recommends appropriate next steps.

In the Classic 3270 interface of OMEGAMON XE for DB2 Performance Expert, you can easily start DB2 SQL Performance Analyzer for analysis wherever SQL statement text is displayed.

## **Identify poorly performing transactions**

By using the transaction-level monitoring features in OMEGAMON XE for DB2 Performance Expert, you can identify transactions with long run times or with performance that degrades incrementally over time. You can send the offending SQL statements to Optim Query Workload Tuner for further analysis.

## **Evaluate query performance before you go into production**

Application developers can use the recommendations that are available in DB2 SQL Performance Analyzer to fine-tune SQL statements, and then use OMEGAMON XE for DB2 Performance Expert and DB2 Query Monitor to validate the performance improvements after the applications are in production.

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## **Accelerated query performance for Business Analytics**

You can use IBM DB2 Performance Solution Pack for z/OS with IBM DB2 Analytics Accelerator for z/OS to identify, monitor, compare, analyze, tune, and manage the DB2 queries that you accelerate.

DB2 Analytics Accelerator uses a massively parallel processing (MPP) engine to make data-intensive DB2 queries run fast.

## Overview

DB2 Analytics Accelerator is a high-performance appliance that offloads costly processing from your DB2 subsystem. DB2 Analytics Accelerator integrates IBM Netezza® and zEnterprise® technologies to provide you with increased processing speed so that you can deliver accurate, timely information to the people who make your most critical business decisions.

**Note:** DB2 Analytics Accelerator is a separately licensed product that is not included in DB2 Performance Solution Pack.

In addition to significantly increasing the speed of complex queries, DB2 Analytics Accelerator also incorporates analytics and predictive modeling into query processing activities. You can manage enterprise-scale volumes of information in real time while you optimize your business intelligence and data warehousing initiatives.

DB2 Analytics Accelerator maintains copies of your DB2 database tables in the Netezza engine. For transactional queries, you can continue to use the high performance of DB2. For longer-running analytical queries, you can use the query engine in DB2 Analytics Accelerator. You define the tables that you want to accelerate, load the data into DB2 Analytics Accelerator, and then refresh the data periodically to maintain data currency.

DB2 Performance Solution Pack supports your query acceleration activities in DB2 Analytics Accelerator in the following ways:

- Identify queries that are the best candidates for acceleration and streamline the selection process.
- Determine the best set of tables to accelerate, based on workload.
- Proactively monitor your accelerated queries.
- Filter out queries that are not accelerated to help you tune your workloads.
- Validate the performance and return on investment (ROI) of your accelerated queries.

The following sections describe how each component of DB2 Performance Solution Pack helps you to achieve massive query acceleration by using DB2 Analytics Accelerator:

### Identify and monitor queries by using DB2 Query Monitor

You can use DB2 Query Monitor to identify and compare accelerated queries. The following examples describe some of the ways that DB2 Query Monitor supports DB2 Analytics Accelerator:

- Tune your queries by isolating accelerated and non-accelerated queries.
- Measure and compare query performance before and after acceleration to demonstrate the return on your investment (ROI).
- Hand off queries to Optim Query Workload Tuner for workload-level analysis, tuning advice, and recommendations for which tables are the best candidates to offload to the accelerator.
- Focus on non-accelerated queries to help you find more queries that might benefit from acceleration.

## Identify candidate SQL for acceleration

The ability to sort by true average elapsed time makes it easier for you to identify queries that run for a long time, and are therefore more likely to benefit from running on the accelerator. DB2 Query Monitor also calculates the number of execution counts and averages by execution count to ensure that your analysis includes equivalent comparisons that accurately reflect the performance benefits.

## Retrieve accurate performance comparisons

When queries run on the Netezza engine, most of the resources that they use are Netezza resources rather than DB2 resources. The ability to compare metrics for the same workload run before and after acceleration helps you to quantify your return on investment. Performance metrics comparisons include both absolute and percentage changes for totals and averages of such metrics as elapsed time, CPU, and getpages.

You can use the Compare feature in DB2 Query Monitor to show performance statistics before and after acceleration. Summary views provide this information at the level of the DB2 subsystem, plan, package, and authorization ID. You can even retrieve information at the level of individual SQL statements. You first choose baseline time intervals in which your workload ran without acceleration, and then compare it with later intervals that you capture after acceleration.

## Compare and tune workloads by using Optim Query Workload Tuner

### Workload Analytics Acceleration Advisor

The Workload Analytics Acceleration Advisor provides robust analysis and administration by capturing and explaining entire workloads. Instead of analyzing individual queries one at a time or resolving referenced tables and views manually, Optim Query Workload Tuner analyzes your entire workload automatically.

The advisor helps you to optimize query acceleration by recommending which tables to offload to the accelerator and identifying queries that are candidates for offload. The advisor can also estimate the performance benefits that you can achieve by accelerating queries. You can easily identify *rewritable* queries that can become candidates for offload if application developers make the recommended enhancements to the SQL statements.

All tables do not contribute to acceleration equally. The Workload Analytics Acceleration Advisor provides *what-if* analysis to help you refine the list of tables that qualify for acceleration and identify the greatest performance benefit. After you offload the tables to DB2 Analytics Accelerator you can easily identify the ones that are no longer beneficial.

You can also analyze your queries at the package level. The advisor provides statistics that measure basic and maximum processor savings and describe resource utilization at the Netezza appliance. You can even analyze requests that remain in queue too long and delay processing.

### Gather statistics and compare access paths

Features that are available in Workload Statistics Advisor help you to optimize performance at the workload level by recommending the required



DB2 statistics. You can also use features that are available in Workload Access Path Comparison to compare snapshots of the access paths before and after acceleration.

You can retrieve the following recommendations by using Workload Statistics Advisor:

- Whether the RUNSTATS utility is required to collect DB2 statistics for the objects in the workload
- Recommended options for the RUNSTATS command, which the Workload Statistics Advisor generates automatically

After RUNSTATS completes processing, you can then run the DB2 EXPLAIN command with an option to determine eligibility for offload. EXPLAIN processing performs the following tasks:

- The EXPLAIN command stores the access paths for your workload in the plan table.
- The optimizer processes the workload and collects data that can determine the eligibility of your queries for acceleration. Later, you can choose whether to offload them to DB2 Analytics Accelerator.
- EXPLAIN processing then retrieves the access paths from the plan table and saves them in a repository that Optim Query Workload Tuner uses for further analysis.

You can then run Workload Analytics Acceleration Advisor on the repository to identify those tables that are the best candidates for offload to DB2 Analytics Accelerator. After offloading the recommended tables, you can then EXPLAIN the workload again so that DB2 can use the new access paths.

You can then use the features in Workload Access Path Comparison to compare *before and after* snapshots of the access paths for both workloads and further optimize any queries that you offloaded to DB2 Analytics Accelerator.

Not all queries can be accelerated. Use other advisors in Optim Query Workload Tuner, such as workload index advisor, workload query advisor, and access path advisor to tune non-accelerated queries.

#### **Workload index advisor**

The workload index advisor considers a set of queries in a query workload. It then looks for ways to improve the performance of the workload or reduce the amount of disk space that is used by indexes on the data server.

#### **Workload query advisor**

The workload query advisor uses a set of best practice rules to consider a set of queries in a query workload and recommends ways that you might rewrite queries in the workload to improve the performance of the workload as a whole.

#### **Access path advisor**

You can use the access path advisor to discover when the optimizer chooses a suboptimal access path to process a query. The access path advisor uses EXPLAIN information to evaluate the access path and warns you if the access path is not optimal.

### **Analyze access paths visually**

Visual EXPLAIN features in Optim Query Workload Tuner provide visual representations of access paths in graph format for analysis. The graphs help you to make knowledge-based decisions that make it easier to tune your workloads. You can easily identify problems with SQL statements and reorganize or redistribute tables.

#### **Tune mixed workloads**

Retrieve tuning recommendations for mixed workloads that consist of both accelerated queries and queries that are not accelerated.

### **Analyze and report on acceleration by using OMEGAMON XE for DB2 Performance Expert**

You can use the powerful suite of tools available in OMEGAMON XE for DB2 Performance Expert to measure the performance of accelerated workloads in DB2 Analytics Accelerator. The following activities show some of the ways that you can retrieve the information that you need:

- Monitor the real-time performance of accelerated queries and threads online.
- Report on utilization metrics for accelerated workloads at the accelerator or application level by running comprehensive batch reports.
- Analyze performance trends by saving accelerator-specific metrics to a performance database.

#### **Monitor and manage query performance**

OMEGAMON XE for DB2 Performance Expert increases your insight into the performance and behavior of your accelerated queries. Monitoring capabilities provide information about accelerated threads in real time, including processor consumption and elapsed time.

You can also run batch programs to capture useful statistics and generate reports about query activities on the accelerator.

#### **Identify candidate workloads for acceleration**

Estimate processing cost and elapsed time for queries that are eligible for offload to DB2 Analytics Accelerator.

#### **Perform trend analysis**

Analyze performance trends by gathering performance metrics that are related to the accelerator and saving them to a performance database. You can then analyze workload performance over time. A spreadsheet generator exports your findings to comma-separated value (CSV) files so that you can open the data in a spreadsheet program for further analysis.

#### **Validate resource utilization and performance improvements**

If you save accounting data to an archive, you can compare application performance before and after acceleration and develop chargeback metrics. You can review processor and elapsed time statistics to demonstrate performance improvements on the accelerator and create reports that validate your return on investment.

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## **Scenarios**

In the following scenarios, a global banking enterprise uses DB2 Performance Solution Pack to optimize the performance of its ATM network and proactively anticipate performance issues before they occur.



The implementation of their performance management strategy occurs in the following stages:

1. “Scenario: Tuning performance by monitoring thresholds and analyzing historical data”
2. “Scenario: Identifying and eliminating top SQL performance inhibitors” on page 18
3. “Scenario: Maximizing query performance with IBM DB2 Analytics Accelerator” on page 18

## Scenario: Tuning performance by monitoring thresholds and analyzing historical data

In the first stage of implementation, the bank uses DB2 Performance Solution Pack to address performance problems that are related to an SQL statement that is nested in a stored procedure. The IT staff also verifies whether problematic events are signs of a trend by analyzing historical data.

The IT organization uses DB2 Query Monitor to track the performance of the online transaction processing (OLTP) system that supports their network of ATM services. One day, query processing exceeds the processor cost that one of the DBAs defined as an acceptable value in a thread threshold parameter.

This event triggers an alert that results in the following actions:

- Email and text notifications are sent to the appropriate IT staff members.
- The offending thread is canceled to protect the system and prevent further delays.

To meet a service level agreement for ATM transactions, response times can be no greater than 15 seconds. When the senior DBA receives an email notification that alerts her to threshold violations on the monitored database, she instructs her team to review all layers of the application.

They use the Extended Insight features of OMEGAMON XE for DB2 Performance Expert to track the transaction across the network, application, operating system, and database. The problem is quickly isolated to a poorly performing query in DB2 for z/OS. They use the SQL dashboard to locate the query, which is nested deep inside a stored procedure. To build institutional knowledge across the organization about these performance analysis capabilities, the DBA shares access to the web console with the lead application developer. In the future, application developers are more likely to recognize the value of beginning the troubleshooting process with a review of the environment as a whole.

This performance problem is unusual, so the DBA consults repositories of historical data in OMEGAMON XE for DB2 Performance Expert to verify that the slowdown is not a sign of a trend. Finding no trends, the DBA captures the SQL within the stored procedure and passes it in context to Optim Query Workload Tuner. Expert advisors gather statistics, modify the SQL statement, create an index, and make an estimate of the anticipated improvements. The team tests the optimized SQL and places it back into production. The performance of the OLTP system is now in compliance with service level agreements.

**Remember:** DB2 Query Monitor also maintains historical data that DBAs can use to analyze trends. If their preferred interface is ISPF, they can use similar features in DB2 SQL Performance Analyzer to tune queries.

Because DB2 Performance Solution Pack reduces the company's reliance on a core group of experts, the senior DBA is able to hand off responsibility to less experienced staff members so that they can develop their skills.

## **Scenario: Identifying and eliminating top SQL performance inhibitors**

In the next implementation stage, the bank uses DB2 Performance Solution Pack to engage in proactive performance tuning by identifying its top 25 performance-inhibiting SQL statements. The IT staff then makes significant improvements to application performance by analyzing the queries, retrieving expert advice, and optimizing the SQL.

After DB2 Performance Solution Pack measurably improves response time to performance issues in the first six months, the organization moves to a new stage of implementation. The CIO assigns a team of DBAs to manage performance across a geographically dispersed DB2 for z/OS environment. They use DB2 Query Monitor daily to generate usage reports that flag excessive processor cycles and identify plans, packages, and SQL statements that perform poorly. Support calls are an additional source of information about jobs that run longer than expected.

The team reviews each job, starting with the ones that have the worst performance. DB2 Query Monitor enables DBAs to quickly and easily drill down and identify both the problem SQL and the specific programs that run the queries. The DBAs can identify the queries either in an ISPF interface or the web-based Consolidation and Analysis Engine (CAE).

A DBA passes a group of SQL statements as a workload to Optim Query Workload Tuner, which then analyzes the workload and processes the information in expert advisors. The tuning process generates recommendations for improvement. After the team tests the optimized SQL, they place the statements back in their respective programs. The DBAs put the applications back into production, and then use OMEGAMON XE for DB2 Performance Expert and DB2 Query Monitor to validate the performance improvements.

DB2 Performance Solution Pack saves the company more than 100 hours a week in manual diagnosis and resolution and cuts processor consumption in half. By eliminating manual labor in the query analysis stage, the company also decreases downtime and associated costs. In addition to refining existing queries, the team now reviews all new and modified queries, including their DB2 EXPLAIN output. If the access path is too costly, they optimize the query in DB2 SQL Performance Analyzer or Optim Query Workload Tuner before they use the code in production.

## **Scenario: Maximizing query performance with IBM DB2 Analytics Accelerator**

In the final stage of implementation, the bank uses DB2 Performance Solution Pack and IBM DB2 Analytics Accelerator to support business intelligence operations in data warehouse environments.

IBM DB2 Analytics Accelerator for z/OS is a query acceleration appliance that can improve query performance on a massive scale. The appliance consists of both hardware and software components. It uses a dedicated IBM Netezza server to maximize query performance by offloading the processing from z/OS to a *massive parallel processing* engine.

The company implements DB2 Analytics Accelerator to improve the response time of large, complex business intelligence queries that are slowing down access to critical business information in data warehouses.

In the testing phase, the senior DBA offloads selected tables to DB2 Analytics Accelerator and compares the results to previous performance benchmarks. DB2 Query Monitor makes it easy to identify and display the offloaded queries. The DBA drills down for operational summaries of query acceleration activities by using an accelerator command. She can review summary statistics at the level of the plan, DB2 subsystem, package, or authorization identifier. She compares query performance with the accelerator turned on and turned off by reviewing accounting statistics that measure elapsed time, getpage activity, and processor time.

DB2 Query Monitor uses trace records and thread analysis to generate robust performance metrics for the accelerated queries. Online and batch reports provide statistical summaries of the performance improvements. The DBA drills down into selected queries to review the SQL text and then transfers some of those queries to Optim Query Workload Tuner for further analysis and tuning. OMEGAMON XE for DB2 Performance Expert can also provide more details about troublesome queries.

Many of the queries show extreme increases in performance that demonstrate huge cost savings.

The DBA wants to generate graphs that visually demonstrate some of the most dramatic performance improvements so she can share her findings with management. She sends statistical summaries to OMEGAMON XE for DB2 Performance Expert, where a data generator utility converts the summaries to comma-separated values (CSV) format. She then creates a graph that illustrates the magnitude of improved query performance when the team turns on the accelerator.

This final stage of implementation delivers massive query acceleration to the company's business intelligence operations and reduces the cost of processing and storage on DB2 for z/OS. IBM DB2 Analytics Accelerator for z/OS enables business analysts to engage in *train of thought* analysis. They are no longer constrained by the speed of the business intelligence software. They can now highlight trends, predict outcomes, and produce better business results in a fraction of the time that was required before implementation. The operations are not apparent to them because, from their perspective, queries simply run faster.

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## Resources

Consult these resources for additional planning, customizing, troubleshooting, and reference information about the product components of DB2 Performance Solution Pack.

### Information centers

#### Tivoli OMEGAMON XE for DB2 Performance Expert on z/OS Version 5.2.0 information center

[http://publib.boulder.ibm.com/infocenter/tivihelp/v15r1/topic/com.ibm.omegamon.xe.pe\\_db2.doc\\_5.2.0/ko2welcome\\_pe.htm](http://publib.boulder.ibm.com/infocenter/tivihelp/v15r1/topic/com.ibm.omegamon.xe.pe_db2.doc_5.2.0/ko2welcome_pe.htm)

#### IBM DB2 Query Monitor for z/OS Version 3.2 information center

<http://publib.boulder.ibm.com/infocenter/dzichelp/v2r2/topic/com.ibm.db2tools.cqm32.doc.ug/topics/cqmhome.htm>

#### **IBM DB2 SQL Performance Analyzer for z/OS Version 4.2 information center**

<http://publib.boulder.ibm.com/infocenter/dzichelp/v2r2/topic/com.ibm.db2tools.anl42.doc.ug/topics/anlhome.htm>

#### **IBM InfoSphere Optim Query Workload Tuner for z/OS Version 4.1 information center**

[http://pic.dhe.ibm.com/infocenter/dstudio/v4r1/topic/com.ibm.datatools.qrytune.nav.doc/topics/helpindex\\_qt.html](http://pic.dhe.ibm.com/infocenter/dstudio/v4r1/topic/com.ibm.datatools.qrytune.nav.doc/topics/helpindex_qt.html)

### **Roadmaps and quick start guides**

#### **OMEGAMON XE for DB2 Performance Expert**

##### **Quick Start Guide for the end-to-end SQL monitoring function**

[http://publib.boulder.ibm.com/infocenter/tivihelp/v15r1/topic/com.ibm.omegamon.xe.pe\\_db2.doc\\_5.2.0/ompe\\_qsg.htm](http://publib.boulder.ibm.com/infocenter/tivihelp/v15r1/topic/com.ibm.omegamon.xe.pe_db2.doc_5.2.0/ompe_qsg.htm) (information center)

[http://publib.boulder.ibm.com/infocenter/tivihelp/v15r1/topic/com.ibm.omegamon.xe.pe\\_db2.doc\\_5.2.0/ompe\\_qsg.pdf](http://publib.boulder.ibm.com/infocenter/tivihelp/v15r1/topic/com.ibm.omegamon.xe.pe_db2.doc_5.2.0/ompe_qsg.pdf) (PDF)

##### **Quick Start Guide: Tivoli OMEGAMON XE Monitoring Agents on z/OS**

[http://publib.boulder.ibm.com/infocenter/tivihelp/v61r1/topic/com.ibm.omegamon\\_share.doc\\_6.3.0.1/om\\_common\\_510\\_quickstart\\_02.htm](http://publib.boulder.ibm.com/infocenter/tivihelp/v61r1/topic/com.ibm.omegamon_share.doc_6.3.0.1/om_common_510_quickstart_02.htm)

#### **Optim Query Workload Tuner**

##### **Quick Start Guide: IBM InfoSphere Optim Query Workload Tuner for DB2 for z/OS**

<http://www-01.ibm.com/support/docview.wss?uid=swg27038277&aid=1>

##### **Information Roadmap for InfoSphere Optim Query Workload Tuner, Version 4.1**

[http://www.ibm.com/developerworks/data/roadmaps/roadmap\\_ioqwt\\_41.html](http://www.ibm.com/developerworks/data/roadmaps/roadmap_ioqwt_41.html)

##### **Roadmap: Installing and configuring InfoSphere Optim Performance Manager to work with Tivoli OMEGAMON XE for DB2 Performance Expert on z/OS**

[http://pic.dhe.ibm.com/infocenter/perfmgmt/v5r2/topic/com.ibm.datatools.perfmgmt.installconfig.doc/roadmap\\_zOS.html](http://pic.dhe.ibm.com/infocenter/perfmgmt/v5r2/topic/com.ibm.datatools.perfmgmt.installconfig.doc/roadmap_zOS.html)

##### **Roadmap: Installing Optim Performance Manager and IBM Optim Performance Manager Extended Insight**

[http://pic.dhe.ibm.com/infocenter/perfmgmt/v5r2/topic/com.ibm.datatools.perfmgmt.installconfig.doc/roadmap\\_opm\\_ei.html](http://pic.dhe.ibm.com/infocenter/perfmgmt/v5r2/topic/com.ibm.datatools.perfmgmt.installconfig.doc/roadmap_opm_ei.html)

### **Planning, installation, and customization**

#### **OMEGAMON XE for DB2 Performance Expert**

##### **Configuration and Customization Guide**

[http://publib.boulder.ibm.com/infocenter/tivihelp/v15r1/topic/com.ibm.omegamon.xe.pe\\_db2.doc\\_5.2.0/ko2cc/ko2cc\\_about.htm](http://publib.boulder.ibm.com/infocenter/tivihelp/v15r1/topic/com.ibm.omegamon.xe.pe_db2.doc_5.2.0/ko2cc/ko2cc_about.htm) (information center)

[http://publib.boulder.ibm.com/infocenter/tivihelp/v15r1/topic/com.ibm.omegamon.xe.pe\\_db2.doc\\_5.2.0/ko2cc\\_book.pdf](http://publib.boulder.ibm.com/infocenter/tivihelp/v15r1/topic/com.ibm.omegamon.xe.pe_db2.doc_5.2.0/ko2cc_book.pdf) (PDF)

### **Parmgen Reference**

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### **IBM Tivoli OMEGAMON XE and IBM Tivoli Management Services on z/OS Common Planning and Configuration Guide**

[http://publib.boulder.ibm.com/infocenter/tivihelp/v15r1/topic/com.ibm.omegamon\\_share.doc\\_6.3/zcommonconfig/zcommonconfig.htm](http://publib.boulder.ibm.com/infocenter/tivihelp/v15r1/topic/com.ibm.omegamon_share.doc_6.3/zcommonconfig/zcommonconfig.htm)  
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### **IBM InfoSphere Optim Performance Manager Extended Insight**

[http://pic.dhe.ibm.com/infocenter/perfmgmt/v5r2/topic/com.ibm.datatools.perfmgmt.ei.overview.doc/topics/helpindex\\_ei.html](http://pic.dhe.ibm.com/infocenter/perfmgmt/v5r2/topic/com.ibm.datatools.perfmgmt.ei.overview.doc/topics/helpindex_ei.html)

### **Messages**

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### **DB2 Query Monitor**

#### **DB2 Query Monitor for z/OS Version 3 Release 2 Users Guide**

<http://publib.boulder.ibm.com/infocenter/dzichelp/v2r2/topic/com.ibm.db2tools.cqm32.doc.ug/topics/cqmhome.htm> (information center)

<http://publib.boulder.ibm.com/epubs/pdf/cqmugc20.pdf> (PDF)

#### **Planning and best practices**

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#### **Post-customization**

[http://publib.boulder.ibm.com/infocenter/dzichelp/v2r2/topic/com.ibm.db2tools.cqm32.doc.ug/topics/cqmucon\\_postcust.htm](http://publib.boulder.ibm.com/infocenter/dzichelp/v2r2/topic/com.ibm.db2tools.cqm32.doc.ug/topics/cqmucon_postcust.htm)

### **DB2 SQL Performance Analyzer**

#### **IBM DB2 SQL Performance Analyzer for z/OS Version 4 Release 2 User's Guide**

<http://publib.boulder.ibm.com/infocenter/dzichelp/v2r2/topic/com.ibm.db2tools.anl42.doc.ug/topics/anlhome.htm> (information center)

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#### **Customizing DB2 SQL Performance Analyzer**

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**Tools Customizer overview**

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**Tools Customizer terminology and data sets**

[http://pic.dhe.ibm.com/infocenter/dzichelp/v2r2/topic/com.ibm.db2tools.ccq.doc.ug/topics/ccqcon\\_termdatasets.htm](http://pic.dhe.ibm.com/infocenter/dzichelp/v2r2/topic/com.ibm.db2tools.ccq.doc.ug/topics/ccqcon_termdatasets.htm)

**Starting and preparing Tools Customizer for use**

[http://pic.dhe.ibm.com/infocenter/dzichelp/v2r2/topic/com.ibm.db2tools.ccq.doc.ug/topics/ccqcon\\_preparetouse.htm](http://pic.dhe.ibm.com/infocenter/dzichelp/v2r2/topic/com.ibm.db2tools.ccq.doc.ug/topics/ccqcon_preparetouse.htm)

**Customizing products and components**

[http://pic.dhe.ibm.com/infocenter/dzichelp/v2r2/topic/com.ibm.db2tools.ccq.doc.ug/topics/ccqcon\\_customizeproductspacks.htm](http://pic.dhe.ibm.com/infocenter/dzichelp/v2r2/topic/com.ibm.db2tools.ccq.doc.ug/topics/ccqcon_customizeproductspacks.htm)

**Optim Query Workload Tuner****Installing IBM InfoSphere Optim Query Workload Tuner, Version 4.1**

[http://pic.dhe.ibm.com/infocenter/dstudio/v4r1/topic/com.ibm.datatools.qrytune.installconfig.doc/topics/ioqwt41\\_top.html](http://pic.dhe.ibm.com/infocenter/dstudio/v4r1/topic/com.ibm.datatools.qrytune.installconfig.doc/topics/ioqwt41_top.html)

**Configuring DB2 for z/OS subsystems for use with IBM InfoSphere Optim Query Workload Tuner**

<http://pic.dhe.ibm.com/infocenter/dstudio/v4r1/topic/com.ibm.datatools.qrytune.installconfig.doc/topics/configdb2zos.html>

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## Chapter 2. Introduction to OMEGAMON XE for DB2 PE

OMEGAMON XE for DB2 PE is a performance analysis, monitoring, and tuning tool for DB2 on z/OS environments.

This product is part of the integrated and complete cross zSeries monitoring solution of the IBM Tivoli OMEGAMON XE family that monitors all DB2 subsystems on z/OS and other resources, such as IMS™, MVS™, or CICS®. OMEGAMON XE for DB2 PE simplifies and supports system and application performance monitoring, reporting, trend analysis, charge back usage, and buffer pool analysis. If problems are encountered you are notified and advised how to continue.

This section introduces you to the basic concepts of the following products:

- IBM Tivoli OMEGAMON XE for DB2 Performance Expert on z/OS
- IBM Tivoli OMEGAMON XE for DB2 Performance Monitor on z/OS

It also provides a short introduction to IBM DB2 Buffer Pool Analyzer for z/OS. IBM DB2 Buffer Pool Analyzer for z/OS is sold as a stand-alone product and is included as part of IBM Tivoli OMEGAMON XE for DB2 Performance Expert on z/OS. The end-to-end SQL monitoring function is only available with IBM Tivoli OMEGAMON XE for DB2 Performance Expert on z/OS and not with the other product IBM Tivoli OMEGAMON XE for DB2 Performance Monitor on z/OS.

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### Function overview

OMEGAMON XE for DB2 PE has three main functions: analyzing a current problem, collecting historical data, and tuning buffer pools.

This product offers several components to help you achieve these goals. The sections below introduce you to the main components used for each goal. For a description of each OMEGAMON XE for DB2 PE component and for an overview of the relationships between the components, see “Components of OMEGAMON XE for DB2 PE” on page 25.

#### Analyzing a current problem

You can use OMEGAMON XE for DB2 PE to analyze current application and system problems. For example, an employee has complained that the system is running slow this morning. You can use one of the following components to analyze and identify bottlenecks and other performance problems:

##### Classic Interface

A VTAM interface for OMEGAMON XE for DB2 PE with conventional menus and panels. Like Performance Expert Client, Classic Interface shows you all of the information necessary to analyze a problem using a fast and reliable VTAM interface. You can monitor and solve a DB2 problem even if the whole LPAR is impacted and a logon to TSO is no longer possible. It includes a realtime and a near-term history monitoring component to give you a comprehensive view of your DB2 subsystem.

##### OMEGAMON enhanced 3270 user interface

An enhanced 3270 user interface for OMEGAMON XE for DB2 PE with predefined workspaces that enable you to quickly and easily diagnose



problems with monitored resources and take action to correct them. You can customize the workspaces to suit your requirements, even design and create your own workspaces and navigation.

#### **Tivoli Enterprise Portal**

A Java-based interface for OMEGAMON XE for DB2 PE that is flexible and customizable. You can install Tivoli Enterprise Portal on the local machine or you can access it through a web browser. Tivoli Enterprise Portal provides information similar to that provided by Performance Expert Client and Classic Interface. When installed in conjunction with the appropriate OMEGAMON products, Tivoli Enterprise Portal can also monitor other products and display the information in the same user interface.

#### **Performance Expert Client**

A graphical user interface for OMEGAMON XE for DB2 PE that runs on the Windows operating system. Performance Expert Client provides all of the functions that are necessary to analyze the system or to analyze a specific application. It shows you all the details about the activity on the DB2 subsystem, plus information about resource utilization and processing times. It also automatically informs you about problems or resource constraints such as deadlock, timeout, or CF structure resize.

### **Collecting and evaluating historical data**

You can also use OMEGAMON XE for DB2 PE to collect and evaluate historical data for different tasks. Historical data is useful for tuning, for problem analysis, for trend analysis, and for capacity planning. For example, you can use historical data to predict resource usage for trend analysis and capacity planning. Historical data also allows you to analyze a problem over a long period of time. This is helpful when current data is not sufficient to analyze the problem, for example when you want to check the size of a DB2 resource, such as an EDM pool, for cursor tables or package tables. You can also use historical data to establish a baseline performance record that can be used to detect deviations. For example, you could collect Accounting data for several months and then compare the current CPU usage time of a static SQL package to the average CPU usage time stored in the history. If the current time is well above the average time, then you know that you need to investigate the change. You can use the following components to store and evaluate historical data:

#### **Performance Database**

A set of tables that can be filled with DB2 performance information collected via SMF or via a batch job using the FPEZCRD program. You can then retrieve, aggregate, or filter the information using SQL. To load the collected DB2 information into the performance database, functions of the reporter component (batch engine) have to be used.

#### **Performance Warehouse**

An automated version of Performance Database. The database is maintained and controlled by the OMEGAMON Collector and you can use a GUI to define the ETL process and to evaluate the information in the tables.

#### **Reporter**

Generates reports that reflect the activity on different levels, for example, subsystem, application, SQL statements, locking, and utility. The Reporter does not store the information in a database. This component helps you identify related problems and charges back the DB2 usage to your users. You can use a command language to filter, sort, and aggregate the reported information.



**Spreadsheet Input-Data Generator**

Creates a comma-separated value (CSV) data set using DB2 trace data processed and formatted by the Reporter and field selection lists. This CSV data can then be transferred to workstations and imported into spreadsheets to improve DB2 performance analysis using graphical representations or pivot tables.

**Tuning buffer pools**

OMEGAMON XE for DB2 PE can also be used to tune buffer pools. If you want to find the optimal use of buffer pool resources and to simulate the effects of possible changes, you can use the following component:

**Buffer Pool Analyzer**

A suite of tools that can be used to monitor, analyze, and tune buffer pools.

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**Components of OMEGAMON XE for DB2 PE**

OMEGAMON XE for DB2 PE is made up of several components, some required and some optional.

Before you can install the product, you must decide which components are necessary for your environment. This section demonstrates the relationships between the components of the products and also gives you a brief introduction to each component.

**Relationships between components**

The components of OMEGAMON XE for DB2 PE work in combination with each other to help you monitor, analyze, and tune your DB2 performance. You need to understand how the components work together in order to decide which components you want to install.

The following graphic demonstrates the relationship between the components of OMEGAMON XE for DB2 PE.

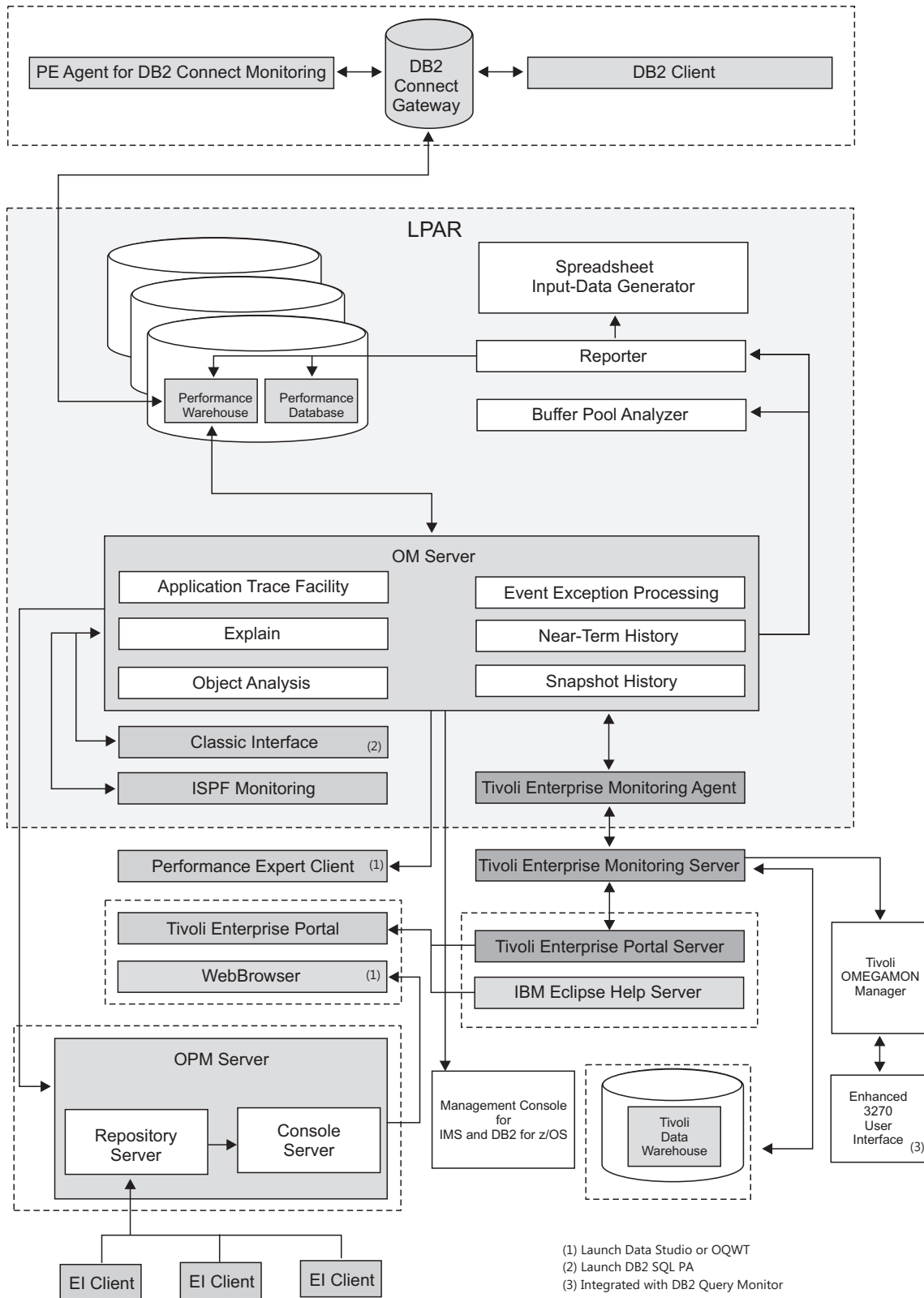


Figure 1. Overview of OMEGAMON XE for DB2 PE components

The following table shows which prerequisite components and optional subcomponents are associated with each main component of OMEGAMON XE for DB2 PE.

Table 1. Main Components, prerequisite components, and optional subcomponents for OMEGAMON XE for DB2 PE

Main components	Prerequisite components	Optional subcomponents
Classic Interface	<ul style="list-style-type: none"> <li>• OMEGAMON Collector</li> </ul>	<ul style="list-style-type: none"> <li>• Application Trace Facility</li> <li>• IBM DB2 SQL Performance Analyzer</li> <li>• Near-Term History</li> <li>• Object Analysis</li> <li>• Performance Expert Agent for DB2 Connect Monitoring</li> <li>• Periodic Exception Processing</li> </ul>
Enhanced 3270 user interface	<ul style="list-style-type: none"> <li>• OMEGAMON Collector</li> <li>• Tivoli Enterprise Monitoring Server</li> <li>• Tivoli Enterprise Monitoring Agent</li> </ul>	<ul style="list-style-type: none"> <li>• None</li> </ul>
Buffer Pool Analyzer	<ul style="list-style-type: none"> <li>• At least one ISPF Monitoring Dialog</li> <li>• Performance Expert Client</li> </ul>	<ul style="list-style-type: none"> <li>• None</li> </ul>
Performance Database	<ul style="list-style-type: none"> <li>• Reporter</li> </ul>	<ul style="list-style-type: none"> <li>• None</li> </ul>
Performance Warehouse	<ul style="list-style-type: none"> <li>• OMEGAMON Collector</li> <li>• Reporter</li> <li>• Performance Expert Client</li> </ul>	<ul style="list-style-type: none"> <li>• None</li> </ul>
Tivoli Enterprise Portal	<ul style="list-style-type: none"> <li>• OMEGAMON Collector</li> <li>• Tivoli Enterprise Monitoring Server</li> <li>• Tivoli Enterprise Monitoring Agent</li> <li>• Tivoli Enterprise Portal Server</li> </ul>	<ul style="list-style-type: none"> <li>• Tivoli Data Warehouse (TDW)</li> <li>• IBM Eclipse Help Server</li> <li>• Performance Expert Agent for DB2 Connect Monitoring</li> <li>• Periodic Exception Processing</li> </ul>
Performance Expert Client	<ul style="list-style-type: none"> <li>• OMEGAMON Collector</li> </ul>	<ul style="list-style-type: none"> <li>• Snapshot History</li> <li>• Periodic Exception Processing</li> <li>• DB2 Event Exception Processing</li> <li>• Performance Expert Agent for DB2 Connect Monitoring</li> <li>• Performance Warehouse</li> <li>• Buffer Pool Analyzer</li> </ul>
Reporter	<ul style="list-style-type: none"> <li>• None</li> </ul>	<ul style="list-style-type: none"> <li>• None</li> </ul>
Web Console for SQL monitoring	<ul style="list-style-type: none"> <li>• InfoSphere Optim Performance Manager Repository Server and Repository DB</li> <li>• OMEGAMON Collector</li> </ul>	<ul style="list-style-type: none"> <li>• Extended Insight (end-to-end SQL Monitoring)</li> <li>• Stored Procedure Monitoring</li> <li>• SQL Dashboard for static and dynamic SQL monitoring</li> </ul>

## Main components

The components in this section are the main OMEGAMON XE for DB2 PE components.

### Buffer Pool Analyzer

IBM DB2 Buffer Pool Analyzer for z/OS helps database administrators manage buffer pools more efficiently by providing information about current buffer pool behavior and by using simulation to anticipate future behavior.

**Note:** IBM DB2 Buffer Pool Analyzer for z/OS functions are sold as a stand-alone product and are included as a part of IBM Tivoli OMEGAMON XE for DB2 Performance Expert on z/OS. The functions and components of the Buffer Pool Analyzer are identical in both offerings.

You can use Buffer Pool Analyzer to analyze the performance data from DB2 for z/OS systems, to simulate changes in the buffer pool settings, to move DB2 objects to a different buffer pool, or to generate reports. The product provides the following functions:

- Comprehensive reporting of the buffer pool activity, including:
  - Ordering by various identifiers (for example, buffer pool, plan, object, primary authorization ID)
  - Sorting by, for example, getpage, sequential prefetch, and synchronous read
  - Filtering capability
  - Loading into DB2 tables
- Simulation of buffer pool usage for:
  - Optimizing the usage of available buffer pool memory
  - Adjusting buffer pool thresholds by grouping objects with like characteristics in the same buffer pools.

For installation instructions, see *IBM DB2 Buffer Pool Analyzer for z/OS Configuration Guide*.

## **OMEGAMON Classic Interface**

The OMEGAMON Classic Interface is a user interface on the host that provides real-time information about a DB2 subsystem.

It is a Virtual Telecommunications Access Method (VTAM) application. It is part of the OMEGAMON Collector. You can use the OMEGAMON Classic Interface to:

- Review the current DB2 activity, such as threads or statistics
- View enclave information from the Work Load Manager (WLM)
- Monitor activity on DB2 gateways using DB2 Connect, and receive enhanced information about DBATs connected by a DB2 gateway.
- Observe counter thresholds
- Review information about terminated DB2 threads using the Near-Term History function
- Analyze objects and drill down into object allocation and usage of thread activities, as well as volume allocation and activities
- Receive detailed runtime performance information at the thread, unit of work, program, and SQL statement level using Application Trace Facility

OMEGAMON Classic Interface includes a realtime and a near-term history monitoring component to give you a comprehensive view of your DB2 subsystem:

### **Realtime component**

The realtime component consists of a realtime monitor that you can use to monitor DB2.

It provides a classic user interface, with conventional menus and panels to facilitate navigation through the product. Through these menus and panels you can access the most current DB2 performance data, like thread use,

locking conflicts, SQL calls, and so on. They also enable you to start and view an application trace to obtain realtime information about application flow and resource consumption.

### **Near-term history component**

The near-term history component consists of the Near-Term History Data Collector, which gathers statistical and accounting information (including distributed database information), DSNZPARM information, and limited performance information from a DB2 subsystem and stores it in VSAM data sets or sequential files, as the activities occur.

Use the near-term history panels to view statistics and thread information that was gathered a few minutes or a few hours ago and to view the current Near-Term History Data Collector specifications.

For more information on how to use OMEGAMON Classic Interface refer to *Monitoring Performance from the OMEGAMON Classic Interface*.

### **OMEGAMON enhanced 3270 user interface**

The OMEGAMON enhanced 3270 user interface is a user interface on the host that provides predefined workspaces that enable you to quickly and easily diagnose and solve problems.

The OMEGAMON enhanced 3270 user interface is the latest generation of 3270 user interfaces for the OMEGAMON family of monitoring products. The OMEGAMON enhanced 3270 user interface is developed upon the common OMNIMON base component and provides DB2 Data Sharing Group reporting. The OMEGAMON enhanced 3270 user interface component enables you to monitor the performance of your z/OS systems, applications, and devices in your environment and helps you to identify and troubleshoot problems with those monitored resources. OMEGAMON enhanced 3270 user interface offers the following features:

- Plex-wide as well as single system views of data
- Autodiscovery of and autoconnection to data sources
- Dynamic behavior and operation
- User-customizable workspaces
- Fastpath navigation
- Lateral and vertical scrolling
- Sorting by column

For installation and configuration instructions, see the *IBM Tivoli OMEGAMON XE and Tivoli Management Services on z/OS: Common Planning and Configuration Guide*.

### **Performance Expert Client**

The Performance Expert Client is a graphical user interface that supports online monitoring and reporting, Performance Warehouse management, and buffer pool analysis on the workstation.

The following list shows what the client comprises when you install the different products:

- If you install OMEGAMON XE for DB2 PE, the client consists of online monitoring, Performance Warehouse with extended Rules-of-Thumb, and buffer pool analysis.
- If you install OMEGAMON XE for DB2 PM, the client consists of online monitoring and Performance Warehouse with limited Rules-of-Thumb.

## Online monitoring and reporting

The PE Client online monitor function allows you to identify bottlenecks, applications that are performing poorly, and areas for tuning improvements. You can review all of the defaults of the current activity at the system and application levels. Snapshot History, an optional subcomponent, allows you to look at historical data. This helps you compare information at various timestamps and to analyze problems that occurred in the past. In addition to these monitoring capabilities, the tool can inform you of specific DB2 situations, such as deadlocks, timeouts, lock escalations, and CF structure rebuilds. Another function called threshold exception processing checks the system or application information for threshold violations. This can help you detect increased usage or unusual usage patterns. The product then uses exits to automatically record this information even if you are not logged on to the Performance Expert Client. The exit writes the information to a system log where it can be picked up by system automation or where it can invoke a batch job that initiates further processing.

## Performance Warehouse management

The Performance Warehouse GUI allows you to control the Performance Warehouse database. You can use it to perform tasks such as defining the Extract-Transfer-Load (ETL) process for collecting and loading data or for creating reports from the collected data. For more information about this component, see “Performance Warehouse” on page 31.

## Buffer pool analysis

The buffer pool analysis GUI lets you control the Buffer Pool Analyzer. You can use it to simulate buffer pool changes so that you can optimize buffer pool memory. For more information about this component, see “Buffer Pool Analyzer” on page 27.

For installation and configuration instructions, see Enabling Performance Expert Client support, SQL Dashboard, or end-to-end SQL or stored procedure monitoring support and Installing and configuring Performance Expert Client.

## Performance Database

The Performance Database is a DB2 database, which can hold aggregated DB2 activity information spanning a long period of time. This long-term history can help you with performance tuning activities, with trend analysis, and with capacity planning.

You can store performance data from the following data groups:

- Accounting
- Audit
- Locking
- Record traces (IFCIDs 22, 63, 96, 125, 172, 196, 316, 365 and 401)
- Statistics and System parameters

You must build, load and maintain the DB2 tables for the Performance Database manually. This allows for greater flexibility. To help you get started, sample library *Erhilev.&Erte.RKO2SAMP* (where *Erhilev.&Erte* is the runtime high-level qualifier) is included in the product. The library contains the following items:

- The definitions of the Data Definition Language (DDL)
- The definitions of the Data Manipulation Language (DML)

- The DB2 LOAD Statements

You must also prepare the performance data with the Reporter functions before you can load it into the Performance Database. The Reporter component provides the data either in timestamp sequence (FILE format) or as reduced data (aggregated data or summary data, called SAVE format).

For installation and configuration instructions, see Adding a Performance Database.

## Performance Warehouse

The Performance Warehouse is a fully automated Performance Database that consists of DB2 tables to save Accounting and Statistics performance counters and internal control tables.

You can perform tasks such as defining the ETL process for collecting and loading data into the database and creating reports from the collected data. You can perform such tasks immediately or you can schedule them to happen automatically after a certain event. For example, you can schedule a task so that reports of the activity are automatically created each morning.

You can use this feature with a database that is created for each monitored DB2 subsystem or with one database for all DB2 subsystems, including subsystems in other LPARS or on different sysplexes. The Performance Warehouse database is automatically maintained by the OMEGAMON Collector. In other words, mandatory changes to the structure of the Performance Warehouse database are automatically performed by the OMEGAMON Collector.

You can evaluate the performance information in the Performance Warehouse databases using a built-in query tool, an external SQL query interface, or Rules-of-Thumb analysis tool. With Rules-of-Thumb you can analyze historical data, identify bottlenecks, resource constraints, and predict trends.

Predefined Rules-of-Thumb are included with the Performance Warehouse, but you can also create your own.

For installation and configuration instructions, see Enabling Performance Warehouse.

## Tivoli Enterprise Portal (TEP)

Tivoli Enterprise Portal is a Java-based browser user interface for viewing and monitoring your enterprise.

The Tivoli Enterprise Portal is a user interface on the workstation that offers a single point of view for online monitoring and analysis. You can view information about all the resources in your IT environment. For example, you can view information about your operating systems, hardware such as routers, applications such as WebSphere<sup>®</sup>, IMS, and CICS, and custom applications. It can run as a browser applet or as a Java<sup>™</sup> application. OMEGAMON XE for DB2 PE gathers data from remote agents residing on the managed systems of your DB2 network and stores this data in system elements called *attributes*.

The monitoring data is received via the Tivoli Enterprise Portal Server (TEPS) and the Tivoli Enterprise Monitoring Server from the Tivoli Enterprise Monitoring Agents (TEMA). Information is then displayed in named *workspaces*.



The Tivoli Enterprise Portal is a customizable interface. For example, you can:

- Configure the workspaces and attributes according to your requirements. The Tivoli Enterprise Portal comes with a set of predefined workspaces for each item in the navigation tree, but you can edit any of them to suit your needs.
- Filter the information presented in a workspace by moving from the top-level workspace to lower-level workspaces.

**Note:** A workspace is not refreshed automatically, however, you can choose to automate the refresh of a workspace at specified intervals.

The Tivoli Enterprise Portal allows you to view a wealth of information, including the following:

- Detailed thread activity information about your DB2 threads, including Workload Manager information
- The interaction of a DB2 system with MVS, CICS, IMS, z/OS, and other systems, databases and applications within a single interface from any location
- Database lock activities and detailed lock conflict information about your database locks
- Information about DB2 resources such as buffer pools, EDM pools, group buffer pools, and dynamic statement caches
- Enhanced information for data base access threads (DBATs) at DB2 Connect gateways
- DB2 log manager active logging and archiving activities
- Distributed Database Facility statistics, including send and receive counts
- Detailed information about threads and thread exceptions connected to DB2
- Information about the performance of volumes that contain DB2 objects so that you can monitor the DASD performance by volume (Group Object Analysis (GOA) Volume workspace group)
- Information about a data sharing group and its coupling facility structures
- Active utility jobs
- DB2 Connect gateway activities

You can use the Tivoli Enterprise Portal to perform the following analysis activities:

- Detecting I/O related bottlenecks such as heavily used volumes
- Analyzing system-wide or application-specific resource usage to tune DB2 resources or to identify applications that are performing poorly
- Using historical information in the short-term history to detect and analyze problems in the past
- Using situations to automatically inform you about problems. You can use predefined situations or you can create your own situations
- Automating problem resolution by taking automatic action when certain events are detected. For example, you can run an MVS job, send a message to a system automation tool, or cancel a thread
- Managing problems detected by your team by using a built-in trouble ticket system or by forwarding the alert to an external event console

For installation and configuration instructions, see *Installing and configuring Tivoli Enterprise Portal*.



## Prerequisite components

The components described in this section are required for one or more of the main components.

### ISPF Monitoring Dialogs

The ISPF Monitoring Dialogs are a user interface on the host that provide access to the main functions or components of OMEGAMON XE for DB2 PE when running under TSO/ISPF.

You can:

- Create and run reporting commands using the Interactive Report Facility (IRF). Here you select the report specification and input data. You create and run reporting commands to generate batch reports.
- View online DB2 activity using the OMEGAMON Classic Interface for real-time monitoring as described in “OMEGAMON Classic Interface” on page 28. From ISPF Monitoring Dialogs, you can access this application through TSO.
- Customize report and trace layouts using the User-Tailored Reporting function (UTR).

You can customize batch report and trace layouts according to your requirements using User-Tailored Reporting (UTR). This function gives you full control over the volume, contents, and layout of your traces and reports.

### OMEGAMON Collector

The OMEGAMON Collector is the central access point for the clients that request to retrieve performance data. It collects history data, exception processing data, trace data, and snapshot data and controls and submits jobs to generate reports and load data into the Performance Warehouse.

The OMEGAMON Collector started task is started with the parameters retrieved from the RKD2PAR library. You can use the MVS operator commands to make changes to the configuration that are effective immediately. For example, you can start or stop specific functions or you can stop the OMEGAMON Collector.

The OMEGAMON Collector hosts the following components:

- OMEGAMON Classic Interface
- OMEGAMON enhanced 3270 user interface
- Tivoli Enterprise Portal
- Performance Expert Client
- Performance Warehouse

It also provides the following services to the components:

- Periodic and event exception processing
- Event Collection Manager to analyze object and volume data

**Note:** You must run this service in a separate address space if you have more than one OMEGAMON Collector or more than one LPAR.

- Near-Term History
- Application Trace Facility
- Snapshot History

## Performance Expert Client as a prerequisite component

Performance Expert Client supports online monitoring and reporting, Performance Warehouse management, and buffer pool analysis on the workstation.

The Performance Expert Client is a prerequisite component for the Performance Warehouse and for the Buffer Pool Analyzer because it provides the user interfaces, or clients, for these components. For more information, see “Performance Warehouse” on page 31 and “Buffer Pool Analyzer” on page 27.

The Performance Expert Client is also a main component. See “Performance Expert Client” on page 29 for more information.

## Reporter

The Reporter generates predefined reports to help you collect and analyze historical performance data. It also enables you to prepare performance data before you load it into the Performance Warehouse or into the Performance Database.

The Reporter comes with the following predefined reports:

- Accounting
- Statistics
- System Parameters
- Utility
- Locking, Audit
- I/O Activity
- Record Trace
- SQL Activity

You can also use a report language to filter, sort, and group the data in the reports according to your preferences. For example, you can include or exclude specific data, sort or summarize by various options, and enable or disable reporting about specific performance data. You can use the User-Tailored Reporting (UTR) function to even further customize the reports.

You can use the Reporter to generate reports in the following ways:

- by submitting a batch job.
- by using the Interactive Report Facility (IRF). You can define the report commands and input data through ISPF panels. You can also submit the reports to run in the background.
- by using the Performance Warehouse Client. You can specify the report commands and input data through a graphical user interface. You can also submit the jobs immediately or schedule them to run later. This only applies to ACCOUNTING and STATISTICS reports.

When you want to load data into the Performance Warehouse or the Performance Database, you can use the command language in the Reporter to indicate which data should be prepared and to indicate how the data should be summarized. You can process the data in the following ways:

- by submitting a batch job.
- by using the Performance Warehouse Client to either submit the job immediately or to schedule the job to run later.

You can use one of the following methods to collect the data that the Reporter uses:

- A batch job. In this case, you use the FPEZCRD program to collect performance data from a DB2 subsystem.
- The Performance Warehouse Client. In this case, you can use a graphical user interface to configure the job and to either submit it or to schedule it to run later.
- The Collect Report Data function in the ISPF Monitoring Dialogs. In this case, you can use ISPF panels to configure the job and to submit it.
- SMF or GTF data sets.
- Sequential data sets generated by Near-Term History Data Collector configured to store trace data to VSAM data sets and sequential data sets (VSAMSEQ).

The Reporter is added when you download the program files from SMP/E. You do not need to perform any additional installation or configuration activities.

### **Tivoli Enterprise Monitoring Agent (TEMA)**

A Tivoli Enterprise Monitoring Agent retrieves performance information from the OMEGAMON Collector for the Tivoli Enterprise Monitoring Server.

A Tivoli Enterprise Monitoring Agent is called by a Tivoli Enterprise Monitoring Server to retrieve data from a monitored resource. These agents then test attribute values against a threshold and report these results to the monitoring servers. The Tivoli Enterprise Portal displays an alert icon when a threshold is exceeded or a value is matched. These tests are called situations.

For installation and configuration instructions, see *Enabling Tivoli Enterprise Monitoring Agent*.

### **Tivoli Enterprise Monitoring Server (TEMS)**

The Tivoli Enterprise Monitoring Server collects and prepares performance information for the Tivoli Enterprise Server.

The Tivoli Enterprise Monitoring Server retrieves information from all of the connected Tivoli Enterprise Monitoring Agents and checks the information for situations. It also keeps a short history that you can view in the Tivoli Enterprise Portal. The history shows you how information has changed over time and allows you to perform actions such as running a batch job on the host when the Tivoli Enterprise Monitoring Server detects a situation.

For installation and configuration instructions, see *Configuring Tivoli Enterprise Monitoring Server*.

### **Tivoli Enterprise Portal Server (TEPS)**

Tivoli Enterprise Portal Server, a gateway between the Hub TEMS and the Tivoli Enterprise Portal, stores user data, workspaces, and queries.

The Tivoli Enterprise Portal uses the Tivoli Enterprise Portal Server to visualize the collected performance information. The Tivoli Enterprise Portal Server works as an application server allowing the Tivoli Enterprise Portal to store configuration data and meta information.

For installation and configuration instructions, see *Installing and configuring Tivoli Enterprise Portal*.

## Optional subcomponents

The components described in this section are optional subcomponents that can be used with the main components.

### Application Trace Facility (ATF)

Application Trace Facility (ATF) traces the execution of a DB2 thread so that you can improve application flow and resource consumption.

The Application Trace Facility collects information about the DB2 thread and shows you the performed operations in a report. It traces the following DB2 thread operations:

- Executed SQL statements.
- Performed sorts.
- Pageset access and scan information.
- Obtained locks.
- Application times, such as in-DB2 Time and in-DB2 CPU Time.

It can be invoked from the Classic Interface: The Application Trace Facility Menu panel provides access to panels from which you can start an application trace, store trace data, review the data collected by an application trace, stop an application trace, and release the storage data set. You can specify the criteria for the application to be traced and to store the trace output. Trace output can have the following formats:

#### In memory trace

Trace data is stored in the virtual storage of the OMEGAMON XE for DB2 PE address space. It is limited to the total amount of storage that is available. The storage is owned by the VTAM session that started the trace. The trace starts as soon as you are completing the start request. If the VTAM session terminates while the trace is running, the trace is terminated and the trace output is lost. When the trace is completed, the data is only available to the VTAM session that started the trace. If the VTAM session terminates, or if you request another in memory application trace, the trace is discarded.

To control the TRACE request, select option **B -VIEW TRACE**. To terminate the trace or to view the trace contents, select option **C - Stop Trace**.

#### VSAM Dataset Trace

The trace is written to a VSAM dataset. It is limited by the size of the dataset. You can define whether the trace is to run immediately or to be deferred (scheduled) for execution at a later time. If the trace is started or scheduled, the VTAM session that requests the trace does not need to stay active for the trace to complete successfully. Information about the trace is maintained for the duration of the OMEGAMON XE for DB2 PE address space, unless it is manually deleted. You can view the trace data from any VTAM session.

To control the trace, select option **H - QUEUED Traces** and select the appropriate element.

The data that is collected by the Application Trace Facility is stored in a VSAM file or resident in memory. If the data is not stored in a VSAM file, it is only available for the current OMEGAMON XE for DB2 PE session.

Stopping trace collection does not delete trace information collected. It simply stops the active trace request. All data collected before trace termination is still available for viewing.

All Application Trace Facility (ATF) panels show the current state of an application trace, including a possible trace data set full condition, as ABENDED, ACTIVE, INACTIVE, or DSN FULL. A state of INIT-XXX might be shown briefly during early stages of initialization.

For installation and configuration instructions, see *Enabling Application Trace Facility*.

## **DB2 Event Exception Processing**

DB2 Event Exception Processing alerts you when specific system events occur. These events include deadlocks, timeouts, locks, escalations, and starts and stops of a coupling facility structure rebuild. This component is also sometimes called DB2 Event Observation.

You can use the Performance Expert Client to see the events and the details of the events.

For installation and configuration instructions, see *Enabling DB2 Event Exception Processing*.

## **Explain**

Explain functions provide an easy-to-read representation of access plan information for your SQL queries and statements. You can use this information to decide how to tune your queries.

The built-in explain functions are Easy Explain and the EXPLAIN report. You can use them as follows:

- You can use the Easy Explain function to view the information while browsing or editing a data set containing SQL statements.
- You can generate an EXPLAIN report that shows access plan information for all of the SQL statements found in the collected performance information.

The following explain functions are optional. They provide access plan information for an individual SQL statement.

- **IBM DB2 SQL Performance Analyzer.** You can use this function through the Classic Interface.
- **IBM InfoSphere Optim Workload Tuner.** You can use this function through the Performance Expert Client.
- **Data Studio.** You can use this function through the Performance Expert Client.

For installation and configuration instructions, see *Enabling DB2 EXPLAIN*.

## **IBM DB2 SQL Performance Analyzer (SQL PA):**

IBM DB2 SQL Performance Analyzer provides resource usage information and costs associated with SQL queries without having to run them in DB2. This analysis helps you tune your queries to achieve maximum performance.

SQL PA calculates the cost of queries before you start them, so that you can tune them before implementation. With SQL PA, you find out how long queries will take before you run them, before resources are consumed, and before the query is

terminated by a governor. You are able to determine the cost of running a query under the attach facilities of IMS, CICS, and batch, as well as TSO, SPUI, and QMF™. The cost estimate is given in familiar units: CPU time, I/O count, and elapsed time, and, in even simpler terms, as QUNITS (a single number representing the overall cost). The monetary cost of each query is also presented.

**Note:** With SQL PA, OMEGAMON XE for DB2 PE enables the user to analyze SQL statements that are displayed in certain VTAM panels. SQL PA analyzes former and current SQL queries and report the results. The results from SQL PA are SQL Enhanced Explain reports, SQL Query Limits reports, and SQL Trace information.

The output provided by SQL PA reports is based on SQL PA configuration parameters specified in PARMGEN. During the customization the affected DB2 subsystems and Performance Warehouse options to be used by SQL PA are determined.

When an SQL performance analysis is requested, the OMEGAMON Collector silently submits a batch job that captures the analysis data and puts it into appropriate Performance Warehouse tables, from where it is retrieved and reassembled and presented as an SQL PA report.

SQL PA reports might be long. If you cannot page down to the end of a report, the “logical rows” session parameter value might be too low. Log on again, with the session parameter set to a higher value. You can set this parameter either on the OMEGAMON XE for DB2 PE Classic Interface panel or as a logon command parameter, for example `logon applid(ipobd2c) data(1rows=9999)`.

For more information, search for *DB2 SQL Performance Analyzer* in the *IBM Knowledge Center*.

## **IBM Eclipse Help Server**

This feature allows you to use the online help in the Tivoli Enterprise Portal.

For installation and configuration instructions, see *Installing and configuring Tivoli Enterprise Portal*.

## **Near-Term History Data Collector**

Near-Term History captures and stores recent DB2 instrumentation data so that you can review thread performance after the threads have ended.

Data captured includes all statistics and accounting records written by DB2. Near-Term History might also collect certain performance data at the thread level, such as dynamic SQL or sorting, locking, and scanning information.

Many events are too short lived to be viewed in real time. Near-term history collection identifies threads that have experienced problems in the past few hours. These threads can then be examined in more detail to help identify the cause of the problem. Some of the types of thread problems that can be identified in this way are:

- Excessive CPU or elapsed time
- Threads that have had timeouts or deadlocks
- Threads committing too infrequently
- Threads that have aborted
- Threads with excessive lock waiting time
- Threads with excessive DB2 wait time for I/O

You can also use the filter options to identify these types of problem threads more quickly.

For installation and configuration instructions, see [Enabling Near-Term History](#).

## **Object Analysis**

The Object Analysis function reveals the affect of an application on overall disk access. This can help you balance the load and determine where DB2 data sets should be placed to evenly spread I/O over available disks.

Object Analysis helps you analyze DB2 object allocations, linear VSAM data set extend activity, I/O activity at the DASD volume level, and object activity from a DB2 perspective. Often the first indicator of a DB2 performance problem is the I/O activity being performed on a particular DASD volume or a DB2 table space or index space. Object Analysis enables you to isolate this activity at a granular level. This can often lead to an understanding of a specific workload or external event that might be contributing to an I/O related DB2 problem.

You can use Object Analysis through the Classic Interface or the Tivoli Enterprise Portal.

For installation and configuration instructions, see [Enabling Object Volume Analysis](#).

## **Performance Expert Agent for DB2 Connect Monitoring**

The Performance Expert Agent for DB2 Connect Monitoring monitors connections of remote applications within the Distributed Relational Database Architecture™ (DRDA®) of DB2 that are connected through DB2. It is installed on the DB2 Connect Server gateway and provides DB2 Connect data for the OMEGAMON Collector.

When Performance Expert Agent for DB2 Connect Monitoring is installed on a DB2 Connect gateway, it collects connection-related data, such as the connection status of a remote application. It also collects statistics about DB2 Connect activities. The collected snapshot data is then stored periodically and can be examined using the user interfaces.

DB2 administrators can use the collected data, for example, to find out whether the connection of the remote application is working. They can also use this data to identify network problems between DB2 Connect and the DB2 server.

For installation and configuration instructions, see [Installing and configuring Performance Expert Agent for DB2 Connect Monitoring](#).

## **Periodic Exception Processing**

Periodic Exception Processing is an OMEGAMON feature that analyzes system metrics and compares them against predefined thresholds, user-defined thresholds, and application metrics.

When a threshold is exceeded, an exception event is shown. This event is commonly called an exception. This function is available in Performance Expert Client.

You can start Periodic Exception Processing manually after you start Performance Expert Client. In this case, you can define a set of thresholds for each user ID. Alternatively you can configure Periodic Exception Processing to automatically



start one user's threshold definitions when the server starts. In this case, the threshold definitions are already started when the user logs on to the client.

For installation and configuration instructions, see [Enabling Periodic Exception Processing](#).

### **Snapshot History**

Snapshot history data is useful, for example, if you want to examine activities leading to, and following, an exception without recreating the situation.

The data is periodically stored by the OMEGAMON Collector in a wrap-around-managed snapshot history data set. You can define how often the snapshots are stored and how many snapshots are stored. When the defined maximum number of snapshots is exceeded, the oldest snapshot is deleted and the newest snapshot is added.

You can view this information through the history mode in the Performance Expert Client. This mode allows you to display recently stored snapshots at a specified point-in-time. You can then scroll forward and backward through the history of snapshot data to get a better understanding of what happened and to identify what caused the problem (for example, detected situations, bottlenecks, deadlocks, timeouts).

For installation and configuration instructions, see [Enabling Snapshot History](#).

### **Tivoli Data Warehouse (TDW)**

You can use the Tivoli Data Warehouse to store collected performance information for a long time. This is helpful when you want to compare DB2 activity that occurred in the past or when you want to review trends.

Other Tivoli products also use this information. For example, IBM Tivoli Performance Analyzer uses this information to predict trends and IBM Tivoli Usage and Accounts Manager uses it to charge back the usage of a system.

For installation and configuration instructions, see [Adding Tivoli Data Warehouse](#).



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## Chapter 3. DB2 Query Monitor overview

IBM DB2 Query Monitor for z/OS (also referred to as DB2 Query Monitor) provides current and historical views of query activity throughout DB2 subsystems.

DB2 Query Monitor enables you to identify problem SQL activity and applications and focus your efforts on improvement. DB2 Query Monitor enables you to:

- Pro-actively manage DB2 resources
- React quickly and effectively to supply and demand-related DB2 problems (such as those resulting from inefficient SQL or inadequate object structures)
- Identify SQL requests that prevent critical requests from completing on schedule

DB2 Query Monitor gives you the ability to efficiently customize and tune your structured query language (SQL) workload and DB2 objects to ensure the effectiveness of your DB2 subsystems and improve overall performance. The tool offers you extensive choices so you can determine what monitoring information you will gather and when you will gather it.

DB2 Query Monitor lets you access alerts from a Web browser and from there you can directly invoke tuning tools on problem SQL statements you've discovered. Improvements in SQL processing let you store data in DB2 making it easier to do statistical analysis on data and create your own reports using tools like QMF and QMF for Windows. DB2 Query Monitor offers the ability to send single SQL statements or whole workloads to IBM Optim Query Workload Tuner, for the analysis of and tuning of SQL queries.

User-defined settings trigger warnings when a threshold is crossed, helping you to avoid unnecessary repair costs. Troubleshooting costs can be reduced by a feature that finds the cause of delays in SQL queries in real time. Using DB2 Query Monitor, you can pinpoint activity important to your business, enabling you to spot potential problems and take steps to resolve these problems quickly.

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### DB2 Query Monitor features and benefits

DB2 Query Monitor provides data collection and activity viewing features as well as exception processing and viewing features.

#### Data collection and activity viewing features

These data collection and activity viewing features are available in DB2 Query Monitor:

- **ISPF view of data sharing group (including across systems)** - ISPF view of data sharing group allows the sharing of data from one Query Monitor subsystem to another via the CAE Server and TCP/IP. This feature enables users to view data from the perspective of a data sharing group.
- **Collects, summarizes, and displays SQL resource consumption down to the level of the individual SQL text statement.** Enables the collection of information about the DB2 resources consumed by your system's SQL activity. Information can be both collected and viewed in whatever way is most useful to you. For

example optional keying is provided that allows collection and viewing of computing resource consumption down to the level of each piece of unique SQL text.

- **Collects, summarizes and displays DB2 object access statistics down to the individual table and index.** Enables the collection of information about what DB2 objects are being accessed by your system's SQL activity. Collected information can be displayed at various levels of granularity down to the level of the individual table and index and related back to the exact request or even to the user who is requiring the access.
- **Enables users to view current activity.** Enables users to view active statements currently being executed by DB2.
- **Enables users to exclude from data collection both entire workloads as well as specific SQLCODES within a workload.** Users can configure monitoring profiles to disable summary reporting for specific workloads, exclude specific -SQLCODES from exception or alert processing, set exception limits and thresholds, and define alert notification thresholds.
- **Fully implements cross-linkage between both the operational (application-based) and structural (DB2 tables and indexes) aspects of SQL request.** Enables users to pinpoint collected SQL activity information from one perspective (for example, from an operational perspective, PLAN, Program, User, SQL statement) and to then easily access collected information from the other perspective (for example, from a structural, table or index, perspective).
- **Provides users with ability to customize monitoring profiles.** Enables users to disable summary reporting for specific workloads, exclude specific -SQLCODES from exception or alert processing, set exception limits and thresholds, and define alert notification thresholds.
- **Supports long text and NLS SQL text collection.** Enables users to capture the full text of long SQL statements without truncation.
- **Collects negative SQLCODE information including associated SQL text if applicable.** Enables users to view the expanded text description for an SQLCODE that is supplied by the IBM utility program DSNTIAR.
- **Collects DB2 command history.** Enables users to view information about the DB2 commands executed on monitored DB2 subsystems.

## Exception processing and viewing features

These exception processing and viewing features are available in DB2 Query Monitor:

- **Collects information relating to exceptional SQL-related events with a complete picture of the environment surrounding the event. This includes the collection of host variables, SQL text, DB2 objects, and buffer pool statistics.** Enables users to collect information (SQL text, object details, lock events, delay events, calls, buffer pools) about their system's SQL-related exceptional events.
- **Performs real-time knowledge-based analysis of exceptional events.** Enables users to analyze and diagnose the conditions under which exceptional events throughout their system occur.
- **Undertakes both notification and curative actions on exceptional events.** Enables users to define the conditions under which notifications are sent to users to alert them of exceptional events on a monitored DB2 subsystem as well as enabling the automation of curative actions to deal with exceptional events as they occur.

## Integrated Storage Manager

The Integrated Storage Manager detects errors before they become serious errors like loops and out of storage conditions. The Integrated Storage Manager enforces storage management rules to avoid the loops and 878/40d abends. A storage constraint is signaled when a storage constraint rule is violated. The purpose of the Integrated Storage Manager is to detect errors before they become serious errors like loops and out of storage conditions.

When DB2 Query Monitor (or Audit SQL Collector) defines its virtual spaces (essentially a 64-bit version of its old data spaces), it defines storage constraint rules. Some examples of the rules include:

- No more than 4096 nesting levels per DB2
- A maximum SQL text allocation per DB2
- A maximum SQL text allocation per Query Monitor / Audit SQL Collector
- No more than 1024 open sections per open thread
- No more than 1024 host variables per section
- No more than 2G total in storage (by default)

When a storage constraint rule is violated, the ISM does not allow any additional storage to be obtained for the type of constrained storage. For example, if thread 1000 attempted to acquire its 1025th section, a storage constraint would be signaled. However, if thread 2000, attempted to acquire its 50th section, it would be allowed.

Storage constraints only impact the violator. When a storage constraint is signaled, a diagnostic entry is created. This constraint is defined by DB2 Query Monitor to avoid a runaway condition that leads to an auxiliary storage shortage.

The Integrated Storage Manager is part of the base DB2 Query Monitor product and does not require activation.

## ISPF view of data sharing group

ISPF view of data sharing group (including across systems) allows the sharing of DB2 Query Monitor data from one Query Monitor subsystem to another via the CAE Server and TCP/IP.

Start-up parameters CAE\_SERVER\_ADDRESS and CAE\_SERVER\_PORT instruct an instance of DB2 Query Monitor to connect to the CAE Server. Once the Query Monitor subsystem has connected to the CAE Server, data will be available for DB2 data sharing members that are being monitored by other DB2 Query Monitor instances that are also connected to the CAE Server.

You have the option to view the DB2 Query Monitor data from a single DB2 subsystem or a DB2 data sharing group.

**Note:** You can view DB2 Query Monitor data from both current and prior intervals using this feature.

The data sharing group displays on the Discovery panel (accessible by specifying ? in the **DB2 QM Subsystem ID** field on the DB2 Query Monitor main menu). On

the Discovery panel, if you select the data sharing group name, DB2 Query Monitor will treat all of the data as if it were from one collector, combining all the data sets into a single view.

**Note:** ISPF view of data sharing group (including across systems) only enables ISPF views of data sharing DB2s. It does not support ISPF views of non-data sharing DB2s on other LPARs at this time.

If a DB2 data sharing group is chosen instead of a Query Monitor subsystem, all data is viewed as if the data sharing group is a Query Monitor subsystem that spans multiple z/OS images.

The first time you enter the discovery interface, you will be prompted to select a CAE Server via a pop-up panel. After selecting the CAE Server, this selection will be saved for future ISPF sessions.

For more information, see *Selecting a CAE Server for ISPF view of data sharing group*.

## Other features

These are additional features available in DB2 Query Monitor:

- **Flexible, consistent, and user-configurable ISPF reporting capability** Enables users to access collected information about their system's SQL activity via a flexible, user-configurable ISPF Client.
- **Enables users to filter data for display purposes.** Users can specify display criteria and thereby refine the level of data detail seen regarding query activity and exceptions.
- **Web-based reporting, viewing and configuration capability** Enables users to access consolidated data and events for DB2 subsystems, whether within a single z/OS image or across multiple z/OS images independent of the existence of a coupling facility. DB2 Query Monitor enables you to view and configure monitoring across your enterprise from a single console.
- **Performs proactive notification.** Enables users to configure and use proactive notification to alert personnel of problems.
- **Supports multi-column sorting, user-customizable column positioning, column resizing.** Enables users to configure custom views that can be saved across sessions.

## Benefits

DB2 Query Monitor provides the following benefits:

- Scalable over the full range of DB2 installations.
- Operates seamlessly in sysplex and stand-alone environments.
- Supports single-console viewing of enterprise-wide DB2 SQL and object access activity.

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## DB2 Query Monitor documentation and updates

DB2 Tools information is available at multiple places on the web. You can receive updates to IMS Tools information automatically by registering with the IBM My Support service.

## DB2 Query Monitor information on the web

The DB2 Tools Product publications web page provides current product documentation that you can view, print, and download. To locate publications with the most up-to-date information, refer to the following web page:

<http://www.ibm.com/software/data/db2imstools/db2tools-library.html>

You can also access documentation for many DB2 Tools from the Information Management Software for z/OS Solutions Information Center:

<http://publib.boulder.ibm.com/infocenter/imzic>

IBM Redbooks® publications that cover DB2 Tools are available from the following web page:

<http://www.redbooks.ibm.com>

The Data Management Tools Solutions website shows how IBM solutions can help IT organizations maximize their investment in DB2 databases while staying ahead of today's top data management challenges:

<http://www.ibm.com/software/data/db2imstools/solutions/index.html>

## Receiving documentation updates automatically

To automatically receive automated emails that notify you when new technote documents are released, when existing product documentation is updated, and when new product documentation is available, you can register with the IBM My Notifications service. You can customize the service so that you receive information about only those IBM products that you specify.

To register with the My Notifications service:

1. Go to <http://www.ibm.com/support/mysupport>
2. Enter your IBM ID and password, or create one by clicking **register now**.
3. When the My Notifications page is displayed, click **Subscribe** to select those products that you want to receive information updates about. The DB2 Tools option is located under **Software > Information Management**.
4. Click **Continue** to specify the types of updates that you want to receive.
5. Click **Submit** to save your profile.

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## DB2 Query Monitor components and architecture

DB2 Query Monitor's components include the monitoring agent, DB2 Query Monitor subsystem, Consolidation and Analysis Engine (CAE), and ISPF Client.

### Monitoring Agent

DB2 Query Monitor's monitoring agent has six data collection points:

- SQL metrics
- DB2 object access
- SQL text
- DB2 commands

- Negative SQLCODEs
- Host variables

Collected data is integrated by the Query Monitor subsystem to provide a complete picture of query activity in a monitored system. DB2 Query Monitor uses an exception-processing layer to identify exceptions and, in turn, to help determine the root causes of identified exceptions.

## Query Monitor subsystem

The Query Monitor subsystem is the point of data collection, interval management, servicing of historical data archival, and implanting and removal of the required instrumentation vehicles.

### Data collector

The data collector consists of the following components:

- Address space initialization
- Control block allocation
- Address space termination and cleanup
- DB2 discovery
- Instrumentation install and de-install
- First-level data summarization
- Backstore population and management
- Exception recognition and notification
- Field diagnostic generation
- Interval processing
- Historical data archival
- Historical data archive history maintenance

### Backstores

Backstore data sets are VSAM data sets that hold information collected by DB2 Query Monitor's collection points (SQL metrics, DB2 object access, SQL text, DB2 commands, negative SQLCODES). One backstore data set is created for each collection point (with the exception of the host variables collection point) on a per-interval basis. Additionally, information about the exceptions and notifications DB2 Query Monitor recognizes and sends are also written to backstore data sets (also on a per interval basis).

#### Notes:

1. There is no backstore VSAM data set for host variables unless EXCPHSTV\_\* data sets are defined.
2. DB2 Query Monitor dynamically allocates its backstore data sets. Users can only control their allocation via start-up parameters specified in CQMPARMS.

### Exception processing

DB2 Query Monitor's exception processing examines both current and historical DB2 transactions from the backstore data sets created by each collection point to locate exceptions and identify any related data that exists about the unit of work that produced the exception. An exception consists of the SQL text that produced the exception as well as information about the environment at the point in time that the exception occurred (such as performance data, object/buffering data, and host variable data).



### Event notification

Event notifications are messages that are generated by the CAE Agent and sent to a message board on the CAE Browser Client. Additional actions such as forwarding event information to the CAE Browser Client, E-mail notification, paging, etc. are possible event notification actions. Notification events are defined as those exceptional conditions which merit immediate consideration. An event is triggered by the occurrence of a negative SQL code, or an SQL statement execution exceeding one or more the alert thresholds defined in a DB2 Query Monitor collector profile. The term **event** refers to **alerts**, **sqlcodes**, and **alert analysis notifications**. Message boards are displayed in the Alert Browser portion of the CAE Browser Client.

### Consolidation and Analysis Engine (CAE)

The Consolidation and Analysis Engine (CAE) is comprised of three sub-components, the **CAE Agent**, the **CAE Server** and the **CAE Browser Client**.

The CAE Server interfaces to any number of DB2 Query Monitor subsystems through any number of CAE Agents per CAE Server. A CAE Agent is required on every MVS image hosting Query Monitor subsystems. Any number of CAE Browser Clients can look at the CAE Server, which serves as a consolidator, looking at the Query Monitor subsystem no matter where that Query Monitor subsystem resides to give a consolidated view.

The CAE Server and CAE Browser Client are deployed on workstations, while the CAE Agent should be deployed on any mainframe that has an active Query Monitor subsystem that you want to be visible in the CAE Browser Client. The CAE Server consolidates all data from multiple CAE Agents into one place and performs real-time knowledge-based analysis. The CAE Agent provides the CAE Server access to the data of all active Query Monitor collectors on the MVS image on which the CAE Agent is deployed. The CAE Browser Client offers users an interface that can combine in one view all the data and exceptions from a single or multiple DB2s in an enterprise, irrespective of z/OS and Sysplex boundaries. The CAE Browser Client also provides powerful filtering and browsing capabilities for both data and alerts.

The CAE Server has several internal components described below in detail. In its role as a consolidator, it combines data and events (e.g. alerts and negative SQLCODES) from multiple Query Monitor subsystems to present them in a unified manner to users in one or more CAE Browser Clients. It also dispatches any queries, profile changes, automated actions, and interactive user actions stemming from the CAE Browser Clients to the Query Monitor subsystems.

In its role as an analysis engine, the CAE Server applies its event-correlation capabilities to evaluate each new event and possibly establish relationships between the new event and existing events (for example, determining a root cause among a group of events). In addition, the CAE Server applies its performance analysis capabilities. Lastly, the CAE Server enables you to associate specific or general event scenarios with automated actions while additionally providing automatic generation of advisories to operators.

The CAE Server can run on any host (of supported platforms) that has network access to the CAE Agent hosts and CAE Browser Client hosts. The CAE Agent is a non-Java address space running under MVS, using no ZFS/HFS facilities. The CAE Agent is required for the CAE Server to be able to access information from the

Query Monitor Collectors on an LPAR. The CAE Agent can run either as a started task or as a batch job under the control of JES. For more information about the CAE Agent, see CAE Agent considerations.

- **Consolidated model of DB2s**—When the CAE Server is launched, it creates a consolidated object model of all monitored DB2s on all z/OS images equipped with a CAE Agent and with Query Monitor subsystems. The mainframe component is used to access the DB2 discovery information for each z/OS image. The unified model can be browsed by the operator from the CAE Browser Client, and is referenced as needed by the correlation manager, performance analyzer, and response manager. This consolidated model also enables DB2 Query Monitor users to see metric DB2 data from a variety of perspectives ranging from a standalone production or test subsystem to a DB2 data sharing group to a complete production enterprise view.
- **User-extensible scopes**—Scopes define subsets of objects in the consolidated model. Scopes can be applied as filters on the Alert Browser and in defining correlations and responses. Objects in the consolidated model include: DB2 subsystems, CAE Agents, Query Monitor subsystems, z/OS systems, data sharing groups, SQL statements and usages of DB2 objects during SQL execution that have executed in a DB2 subsystem. Scopes are a critical element in the implementation of autonomic behavior enabling users to target responses to event scenarios based on not only the type of event, but also the subject of the event and the context in which it occurred. Some examples of scopes include:

```
Some sql where sql.programName = "RAARDBX1"  
some sql where sql.plan = "QMF72"  
and sql.authorizationId = "JOE"
```

The CAE Browser Client provides a user-friendly graphical interface that is menu driven and context sensitive enabling users to quickly and painlessly define scopes.

- **Centralized browsing facility**—Enables you to browse object, metric and other data from all systems and across LPARs.
- **Centralized configuration facility**—Although the originals for Query Monitor subsystem profiles are stored in the Query Monitor subsystems, the CAE Server can download them on demand for editing by the CAE Browser Client, and upload modifications back up to the Query Monitor subsystems for persistent storage. This enables users to combine the profile configuration activities required for several Query Monitor subsystems along with configurations unique to the CAE under the common user interface umbrella of the CAE Browser Client.
- **Event manager**—The event manager receives unsolicited alerts (which are a kind of event) from multiple Query Monitor subsystems, processes them and filters them before they are processed by the correlation manager, performance analyzer and response manager, and made available for viewing to CAE Browser Clients. The CAE is delivered with a library of event types to represent common SQL execution problems, negative SQL code groups that require immediate attention, and higher-level inferred root causes and performance problems generated by correlations and the performance analyzer respectively.
- **Correlation manager**—The correlation manager evaluates correlations rules over events as they arrive in the event manager. The evaluation of correlations can have the following consequences:
  - Establish relationships (most often cause and effect) between the events.
  - Generate root cause events in order to pinpoint to the operator a single root cause for a collection of other events or exceptions.



- Generate advisory events suggesting corrective actions to be taken by the user.
- Automatically clear events that are inferred to be false positives.

Correlation processing occurs continually on events stemming from the DB2 Query Monitor subsystems as well as events stemming from previous correlation processing and performance analysis.

- **Response manager**—The response manager evaluates all incoming events in accordance with a set of responses defined by the user. Each response configuration specifies one or more actions to execute as a result of an event scenario. For example, responses can be used to automatically send E-mails to authors of SQL statements that exceed proscribed thresholds, and automatically cancel threads that exceed others. Actions to execute include cancel thread, Email, Script execution (JCL, Operator Commands, etc.), and WTO.

## Support Services Address Space (CQMMSTR)

For each MVS image, a Support Services Address Space (also referred to as the master address space) named, by default, CQMMSTR or ADHMSTR (for Guardium S-TAP) will be started after the first instance of DB2 Query Monitor or Guardium S-TAP is started.

**Note:** Although the default Support Services Address Space is named CQMMSTR or ADHMSTR by default, the default name can be overridden by specifying another name via the MASTER\_PROCNAME parameter. For more information, see Collector and ISPF parameters.

This address space serves as a service address space for all instances of Query Monitor and Guardium S-TAP running on the MVS image. The address space does not execute any code during the course of existence, except for its initialization routines so therefore does not have to be controlled by an installation. For more information, see Starting the Support Services address space.

## ISPF Client

The DB2 Query Monitor ISPF Client consists of a series of ISPF panels that provide an interface that enables users to work with monitoring agents and profiles, view activity, exceptions, information about negative SQLCODES, and DB2 commands.

- **Panel help**—Query Monitor's ISPF Client supports panel help. Users can access panel help by pressing PF1.
- **Column help**—Query Monitor's ISPF Client supports context sensitive column help. Users can access column help by typing the CHELP command in the option line, then placing the cursor on the column of interest, and pressing Enter. A help panel displays a definition of the column. The CHELP command is valid on any Query Monitor ISPF panel that displays data in columns. If a panel does not contain columns (for example, a panel can contain a list of information or options) then the CHELP panel is not valid for that panel.

## CAE Browser Client

The CAE Browser Client offers users an interface that can combine in one view all the data and exceptions from a single or multiple DB2s in an enterprise irrespective of z/OS and Sysplex boundaries. The CAE Browser Client also provides powerful filtering and browsing capabilities for both data and alerts.

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## Mainframe operating system and environment

The following are the operating system and environment requirements for DB2 Query Monitor's mainframe components.

**Attention:** Do not run DB2 Query Monitor with similar SQL monitoring products against the same DB2 subsystem because this might result in unpredictable results for DB2.

The monitoring agent, Query Monitor subsystem, ISPF Client, and CAE Agent run on a mainframe system and require the following operating system and environment:

- IBM z/OS Version 1.9 and later
- DB2 Version 9 and later
- ISPF Version 4 and later
- If you want to run the CAE Server under USS, the most current maintenance of (31 bit) Java 1.6 (including all prerequisites) must be installed on your mainframe. 64-bit Java is not supported.

**Note:**

1. This requirement applies to running the CAE Server under USS and is not required if you only plan to run the CAE Agent on an LPAR.
  2. Java builds are available at: <http://www-03.ibm.com/systems/z/os/zos/tools/java/>
- z/OS support for Unicode

**Note:** The installation of z/OS support for Unicode with SMP/E is described in *z/OS Planning for Installation (GA22-7504)*.

- The HFS for the installation of DB2 Query Monitor must be new or empty. Specifically, it must not contain any files from previous versions of DB2 Query Monitor. If you want to retain CAE customizations from prior versions, customize and run the CQMCMGRT samplib member.
- DB2 Query Monitor requires that the HFS in which the CAE Server components are installed must be on DASD that is shared between primary and backup servers (to support fail over server capability in the CAE).
- The total capacity of the two ZFS or HFS file systems used by the CAE Server under USS (if you choose to run the server under USS) should be 1 GB (1200 cylinders).
- The user ID that the CAE Agent runs under must have an OMVS segment. For more information see *Configuring an MVS user ID to run the CAE Agent*.
- The CAE Server must not be made available on the public internet. If you would like users to access the CAE Server from outside your network, they must do so only via a VPN connection.

### Considerations for SMP/E cross-zone requisite checking

Your system may contain products that are packaged and installed separately, but which have service level or interface dependencies. For example, the installation of software service to DB2 Query Monitor, Guardium S-TAP, or Capture Replay, often requires the synchronization of service levels. Those products may be installed across multiple SMP/E zones. For example, service for software in the DB2 Query Monitor zone may require related service for the STP zone to permit all software within the system image to operate properly.

To help ensure proper synchronization across zones, you can tell SMP/E to automatically check for cross-zone requisites during APPLY, ACCEPT, and RESTORE command processing. To enable automatic cross-zone requisite checking, you must tell SMP/E which zones contain software to be checked for requisites. Multiple methods for implementing this process are described in the *SMP/E User's Guide* (SA22-7773-12).

### Other considerations

- If you are migrating to V3.2 from a previous version of DB2 Query Monitor, review the migration recommendations in Upgrading.
- DB2 Query Monitor V3.2 cannot monitor the same DB2 subsystem as DB2 Query Monitor V3.1 since both versions require that the package names be CQMXXXX where XXXX is the DB2 subsystem name, thus prohibiting the running of both versions simultaneously. Additionally, to run DB2 Query Monitor V3.2 on a subsystem on which you previously ran DB2 Query Monitor V3.1, you must REBIND the appropriate plans before you start the Query Monitor collector.
- Each Query Monitor subsystem requires the creation of its own unique set of supporting data sets including CQMINTER, CQMPARMS, and the back store VSAM data sets (DB2CDATA, TEXTDATA, METRDATA, OBJSDATA, EXCPDATA, EXCPINDEX, SQLCDATA, EXCPHSTV, and EXCPTTEXT). Each Query Monitor subsystem also requires a CQMPROFS data set; the CQMPROFS data set is the only DB2 Query Monitor data set that can be shared by Query Monitor subsystems; no other data sets can be shared.
- At ISPF dialog start-up DB2 Query Monitor verifies that translations are available from the CCSIDs 500 and 1208 and the CCSID of the user's terminal. Conversion services must be configured to support the translations. Verify that the appropriate CCSID (code page) conversion has been added to the MVS unicode table in SYS1.PARMLIB.

**Note:** If needed, you can specify the CCSID in the DB2 Query Monitor start-up CLIST. The ZTERMCID keyword can be passed to CQM\$MAIN in the CQMCLIST CLIST. The parameter ZTERMCID is passed to CQM\$MAIN as follows: CQM\$MAIN ZTERMCID(*nnnn*) Where *nnnn* is the CCSID of the ISPF user's terminal.

- The DB2 Query Monitor dispatching priority should be equal to or above DB2.

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## CAE operating system and environment

These requirements provide guidelines for the necessary operating system and environment needed to run the CAE components.

**Note:** These requirements are guidelines. Actual requirements vary depending on the types of equipment in use.

For CAE Server host:

- **Operating System:** Windows XP, Windows 7
- **RAM:** 1GB
- **Disk Space:** 1 GB free
- **Processor Speed:** Pentium IV, 1 GHz
- **Network Access Speed:** LAN, T1, DSL, or cable modem
- **Network Protocols:** TCP/IP
- **Display Requirements:** SVGA monitor; 256 colors or greater

For CAE Browser Client:

- Firefox 2.0.0.13 or later, Internet Explorer V8 or later.
- Adobe Flash Player 10

**Note:**

The disk space required by DB2 Query Monitor includes:

- 768 MB RAM, 1 GB for the CAE Server
- There are no disk space requirements for the CAE Browser Client

## Restrictions - Windows 7 or Windows Vista

If you are using Windows 7 or Windows Vista and intend to install or import a secure socket certificate file using `cqm_cert_install.bat` or `cqm_import_certs.bat`, you must use a command prompt with administrator privileges. To do so, navigate to `\windows\system32` in Windows Explorer, right-click on `cmd.exe`, select **Run as administrator**. Then execute the scripts required.

## Restrictions - CAE Server

The CAE Server must not be made available on the public internet. If you would like users to access the CAE Server from outside your network, they must do so only via a VPN connection.

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## Integration points

The following describes the various integration points between DB2 Query Monitor and other products.

### IBM Tivoli Omegamon XE (formerly IBM DB2 Performance Expert)

- **Offload** - DB2 Query Monitor's offload tables include a column, `CLIENT_ENDUSER`, that is a 128-byte field that enables the data offloaded in that column (from DB2 Query Monitor) to be easily joined with data in DB2 Performance Expert tables.
- **ISPF Client** - No integration
- **CAE Browser Client** - No integration

### IBM SQL Performance Analyzer

- **Offload** - No integration
- **ISPF Client** - DB2 Query Monitor supports IBM SQL Performance Analyzer (SQL/PA) Versions 2.1, 2.2 and higher.
- **CAE Browser Client** - No integration

### IBM DB2 Analytics Accelerator

- **Offload** - No integration
- **ISPF Client** - DB2 Query Monitor indicates whether a query ran in IBM DB2 Analytics Accelerator from within **View Summaries > Optional Summaries**.
- **CAE Browser Client** - DB2 Query Monitor indicates whether a query ran in IBM DB2 Analytics Accelerator from within **View Summaries > Optional Summaries**.

## Query tuning clients

- **Offload** - The following columns in the SYSTOOLS.CQM32\_SUMM\_METRICS table support the tuning client integration: EXECUTION\_COUNT and CURRENT\_SCHEMA.
- **ISPF Client** - No integration
- **CAE Browser Client** - Integrates with:
  - IBM Optim Query Tuner, Version 2.2 (or later)
  - IBM Optim Query Workload Tuner Version 3.1 (or later)
  - IBM DataStudio Version 3.2 (or later)



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## Chapter 4. DB2 SQL Performance Analyzer overview

IBM DB2 SQL Performance Analyzer for z/OS (also referred to as DB2 SQL PA or SQL PA) is a query analysis tool that you can use to optimize the performance of your SQL statements for DB2.

### Topics:

- “What does DB2 SQL Performance Analyzer do?”
- “DB2 SQL Performance Analyzer features and benefits”
- “DB2 SQL Performance Analyzer components and facilities” on page 62
- “DB2 SQL Performance Analyzer architecture and process flow” on page 64
- “DB2 SQL Performance Analyzer operating environments” on page 65
- “DB2 SQL Performance Analyzer documentation and updates” on page 66

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### What does DB2 SQL Performance Analyzer do?

DB2 SQL Performance Analyzer provides you with an extensive analysis of SQL queries without running them. This analysis helps you to tune your queries to achieve maximum performance.

DB2 SQL Performance Analyzer prevents problems associated with long-running queries by calculating the cost of queries before processing them. DB2 SQL Performance Analyzer tells you how long queries will take before you run them, before resources are consumed, and before the query is terminated by a governor. DB2 SQL Performance Analyzer determines the cost of running a query under the attach facilities of IMS, CICS, batch, TSO, SPUFI, and QMF. The monetary cost of each query is presented and a cost estimate in familiar units: CPU time, I/O count, elapsed time, and as QUNITS (a single number that represents the overall cost). Data and content are presented in easily readable reports.

Easy Explain provides you with information about how DB2 accesses data for a given SQL statement. Easy Explain can be used in both TSO and batch. Easy Explain compares the costs of old and new plans and provides the ability to re-explain existing plans that are stored in any plan table. Programming language data sets can be scanned directly to extract SQL for analysis.

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### DB2 SQL Performance Analyzer features and benefits

SQL PA includes several performance features that provide for fast and efficient processing without affecting the system.

### Topics:

- “Generic plan tables” on page 56
- “Catalog access” on page 56
- “Remote operation through DRDA” on page 56
- “DB2 SQL Performance Analyzer stored procedure capability” on page 57
- “SQL Advisor” on page 57
- “Actual query cost” on page 58
- “Exclude WHERE CURRENT OF statements from Query Limit reports” on page 58

## Generic plan tables

To eliminate the need for each user to have their own *authid*.PLAN\_TABLE for the EXPLAIN output, DB2 SQL Performance Analyzer can use a set of generic plan tables in a specifically designed segmented table space.

Using generic plan tables provides for both immediate and simultaneous access, scratch, and reuse of the generic tables with mass delete (a single I/O to drop all entries). By registering each generic copy in use, you can avoid conflicts during concurrent use of DB2 SQL Performance Analyzer. Concurrent DB2 SQL Performance Analyzer users can process against these generic plan tables without conflict. You can change the settings during configuration. You can also create generic DSN\_STATEMNT\_TABLE tables and DSN\_FUNCTION\_TABLE tables.

If you are not using secondary authorization IDs and generic plan tables, you can use SQL PA under a primary authorization ID, if a valid plan table exists under that authorization ID. DB2 SQL Performance Analyzer automatically detects this situation and switches from the generic to the primary plan table. Users in this situation should avoid assigning query numbers above 100 000 000 for their own EXPLAIN operations, because DB2 SQL Performance Analyzer deletes all queries above this number upon invocation.

The authorization ID that is used to customize DB2 SQL Performance Analyzer should not be a generic ID. Generic IDs should not be used outside of DB2 SQL Performance Analyzer. For example, generic IDs should not be the owner of a package that might contain static bind information that the user would want to keep. The EXPLAIN tables of generic IDs will be cleaned up upon invocation and are intended to be "owned" by SQL PA.

To provide direct selection of specific PLAN\_TABLE, DSN\_STATEMNT\_TABLE, and DSN\_FUNCTION\_TABLE tables, DB2 SQL Performance Analyzer provides the USEPLAN and SETPLAN parameters.

## Catalog access

DB2 SQL Performance Analyzer accesses the catalog for information about the table spaces, tables, indexes, and relationships that are determined by each access path, and retrieves critical size and cardinality data that is used as input to the cost assessment process.

DB2 SQL Performance Analyzer accesses the catalog only once for each object sought, even if many queries use the same tables or indexes in their access path. DB2 SQL Performance Analyzer stores the details for hundreds of each object type in memory, and checks this information cache before attempting to access the catalog again. Catalog access is available for the SYSTABLESPACE, SYSTABLES, SYSINDEXES, SYSKEYS, SYSRELS, SYSCOLUMNS, SYSSYNONYMS, and SYSROUTINES tables.

## Remote operation through DRDA

DB2 SQL Performance Analyzer can run a remote copy of DB2 SQL Performance Analyzer on another DB2 subsystem, on the same z/OS server, or on another z/OS server by using the DRDA protocol and the SQL CONNECT statement.

The remote locations must contain fully installed versions of DB2 SQL Performance Analyzer, including a REGISTRY and the following explain tables:

- PLAN\_TABLE



- DSN\_STATEMNT\_TABLE
- DSN\_FUNCTION\_TABLE
- DSN\_DETCOST\_TABLE
- DSN\_PREDICAT\_TABLE

Users can initiate DB2 SQL Performance Analyzer on any system that contains a valid copy of the product and run their SQL by using any other valid copy and DB2 subsystem through DRDA Connect facilities. Results are returned back to the local system for presentation, storing report files, and other tasks. This feature provides the ability to quickly diagnose production problems.

This feature operates in TSO and batch modes only.

## DB2 SQL Performance Analyzer stored procedure capability

DB2 SQL Performance Analyzer can operate as a stored procedure, which enables users from anywhere in the network to call DB2 SQL Performance Analyzer for a cost estimate in real time, from DB2 applications, IMS, CICS, remote workstations, PCs, or any other compatible connection.

Users receive a quick and comprehensive view of how long their queries are likely to run, along with any warning flags about exceeding the limits that are defined in the configuration parameters.

The IBM Resource Limit Facility (RLF) governs the processor time that is spent for dynamic queries only, and only within the DB2 address spaces. If the limit is exceeded, the query ends while in process. However, with the DB2 SQL Performance Analyzer stored procedure, you can develop applications with a built-in governor for queries that can preempt any RLF cancellations. This feature provides you with control and flexibility to handle larger requests.

Whether the query is running under IMS, CICS, or is from a remote client workstation, the following call to the DB2 SQL Performance Analyzer stored procedure is required:

```
EXEC SQL CALL ANLPRCR (<varname>)
```

The parameter list includes the SQL statement to be analyzed, its length, any DB2 SQL Performance Analyzer user parameters that you want to work with, and several output host variables that are populated with DB2 SQL Performance Analyzer cost estimates and warning flags.

DB2 SQL Performance Analyzer provides a stored procedure for use with WLM-controlled address spaces. This stored procedure is named ANLPRCR and uses the Recoverable Resource Manager Services Attach Facility (RRSAF).

A PL/I sample program and a COBOL sample program are provided for the stored procedure environment. Use these sample programs to learn about and design programs that use the WLM stored procedure. Both the source code and the executable modules of the PL/I sample programs are included.

## SQL Advisor

The SQL Advisor finds and presents opportunities for fine-tuning performance.

It uses a comprehensive set of warnings, alerts, and recommendations to convey this information. The SQL Advisor can also issue guidelines, notes, and other informational messages to assist you in understanding the logic behind certain

design decisions and tuning choices. All advice is integrated into the Explain and Detail Trace reports. You control how much information is generated.

## Exclude WHERE CURRENT OF statements from Query Limit reports

The WHERE CURRENT OF clause can cause values that exceed limits set for acceptable query statements. If you are familiar with all of your WHERE CURRENT OF clauses, you can exclude them from your Query Limit reports.

The DSPWCOC parameter provides you the ability to exclude the WHERE CURRENT OF statements from the Query Limits report. Set this parameter to NO to have WHERE CURRENT OF statements excluded from the Query Limits report.

## Actual query cost

The total impact of SQL queries that are processed by DB2 is difficult to assess. One reason is because obtaining and recording all of the cost data in one place for a specific query is difficult.

For example, DB2 records some of the processor time that is used by a specific query in the Type 101 Accounting SMF record. However, this time does not represent all of the processor time that was used by the query.

The Sequential and List Prefetch, Asynchronous Writes, Thread Management, part of Lock Management, and other processes are performed by DB2 for you, and charged to one of its own address spaces. Consider the DB2 processor time distribution, as shown in the following figure.

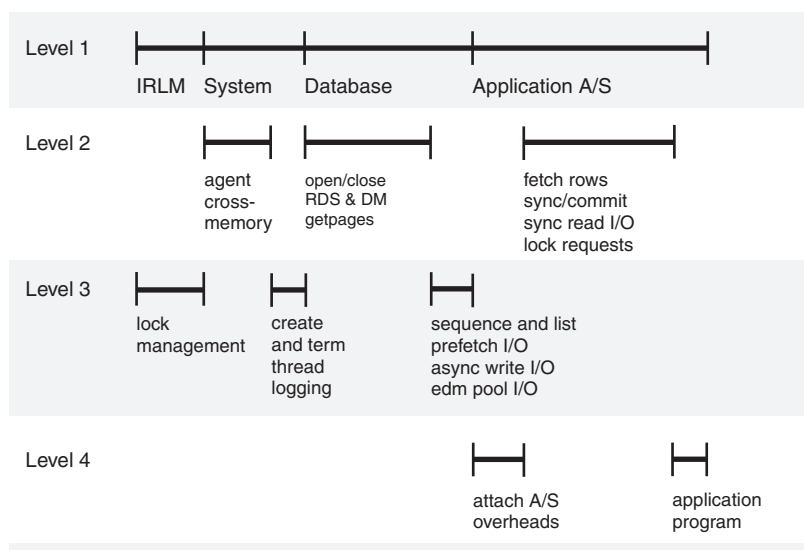


Figure 2. Processor time distribution

Processor time distribution has the following four levels.

### LEVEL 1

This level includes the entire ASCB CPU times that are recorded for a typical transaction, including the IRLM and Application A/S (CICS, IMS). This level represents the full cost of a transaction in processor consumption terms.

## LEVEL 2

This level includes that portion of the CPU times that are reported by DB2 as CPU times (TCB, SRB, and Total) in SMF 101 of the individual user.

## LEVEL 3

This level includes the CPU times that DB2 does not report for each user. The CPU times are reported for the entire system (ASCB CPU Time) in SMF 100.

## LEVEL 4

This level includes the application init/term/overheads and program processing that is not recorded by DB2.

As the previous figure shows, assembling all the components of DB2 processor time is not a trivial matter. Looking at the processor time in the SMF Type 101 accounting record yields only part of the processor time that is used by the query. The remainder of processor time is included in the SMF Type 100 statistics record, along with the usage for many other queries, recorded at periodic time intervals. Some components of DB2 processor times are not recorded at all. Although RMF™ can provide the total resource consumption by address space, only DB2 SQL Performance Analyzer can correlate these costs to the specific users who caused them.

Consider the following breakdown of processor time.

- Within the DB2 DATABASE SERVICES address space:

### **SRB (always run before any TCB):**

1. Database writes (async write)
2. Sequential and list prefetch
3. Part of thread creation

### **TCB (in priority sequence):**

1. VSAM open and close
2. Space management
3. BSDS activity
4. Statistics recording

- Within the DB2 SYSTEM SERVICES:

### **SRB work:**

1. Checkpoint logging
2. Physical logging

### **TCB work:**

1. Archiving
2. Space management

- Within the DB2 IRLM:

### **TCB Work:**

1. Deadlock detection

- Within the USER (Application) address space:

### **TCB activity:**

1. SQL processing
2. Sync reads
3. Sync writes

4. Lock requests or acquire
5. Lock release
6. Logical logging

Much of the processing that happens outside the scope of the address space of the user is absorbed by DB2. The true cost of each DB2 query might not be adequately represented by the SMF 101 accounting record or by the DB2PM accounting report (or its equivalents). Because DB2 absorbs some of the query costs, some users consider the processor usage of DB2 to be high. The bulk of this processor usage is merely DB2 working on behalf of its users and absorbing the costs internally. Even I/O that is performed by the Media Manager under Database Services A/S is not recorded reliably by SMF within the records (including Job and Step termination) of the user.

In a DB2 SQL Performance Analyzer cost summary, all of the processor time factors are considered. The fully loaded costs of each query are represented in a forecast of resource consumption that is based on each particular form of query.

DB2 SQL Performance Analyzer can split the cost analysis into incremental components, so that you can see exactly where each query is spending most of its time. DB2 SQL Performance Analyzer does analysis without having to run the query, which is valuable for long-running queries against large databases.

Along with the processor time for asynchronous I/O, DB2 SQL Performance Analyzer forecasts the actual counts of sequential and list prefetch, and synchronous read I/O counts, all of which are sometimes difficult to predict. Even more so, the asynchronous writes of those pages that are updated by inserts, updates, and deletes, and the DB2 logging activity that is associated with those writes, are almost never shown in the Type 101 Accounting record. The writes are not shown because they occur after the query terminates. DB2 SQL Performance Analyzer can correlate them directly to the query that caused them. The writes are used to determine a realistic response time that includes the processor usage of the delivery vehicle, be that TSO SPUFI, or IMS Wait for Input. Consider the elapsed time distributions that are shown in the following figure.

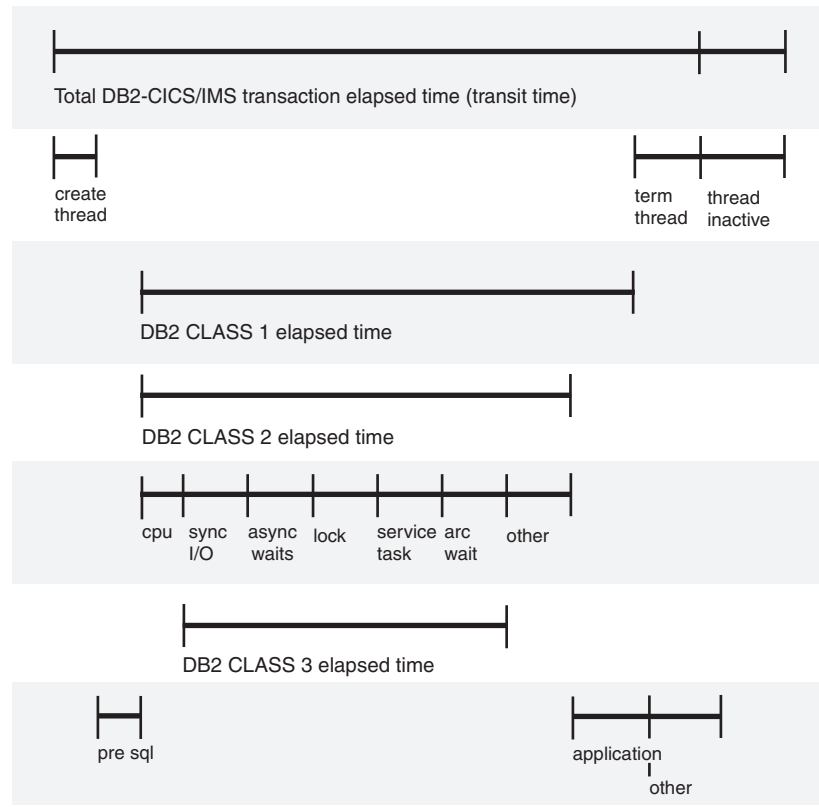


Figure 3. Elapsed time distribution

The entire elapsed time of the transaction includes some portions that are not captured in DB2 class 1 elapsed time, such as create and terminate thread, plus any DBMS processor usage (CICS/IMS init/term/scheduling).

Class 2 elapsed time is a subset of class 1 and represents the time spent in DB2 asynchronous and synchronous only. Class 3 elapsed time includes the synchronous I/O and lock wait times, and is a subset of class 2. It also includes the asynchronous I/O wait times, and Service Task (SRB) and Archive Log waits.

The last component of elapsed time is application time, which is partially captured in DB2 class 1 for SQL-related activities, and partially not captured for subsequent processing of the rows after fetch.

DB2 SQL Performance Analyzer provides an end-to-end view of elapsed time for each of your queries. It also highlights the work done by the system, after your query ends, in support of insert, update, and delete pages that are logged and rewritten to DASD on your behalf. DB2 SQL Performance Analyzer can provide a more resource-intensive view of how your SQL is processed, and a direct comparison back to SMF accounting records validates part of the cost that is presented by DB2 SQL Performance Analyzer.

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## DB2 SQL Performance Analyzer components and facilities

DB2 SQL Performance Analyzer is comprised of several main components. DB2 SQL Performance Analyzer uses the DB2 call attachment facility (CAF) or the recovery resources manager attach facility (RRSAF) to interface directly with DB2.

### Topics:

- “Parser and catalog interfaces”
- “Resource estimator”
- “CAF features that enhance DB2 SQL Performance Analyzer” on page 63
- “Easy Explain” on page 63

## Parser and catalog interfaces

The parser and the catalog interfaces find important SQL and store it in a list.

### SQL parser routine

The SQL parser routine finds the executable SQL in any sequential file, PDS member, or DBRM module (all DBRMs are supported). The SQL parser extracts those statements and assigns Explain query numbers to them. The following numbering convention is used:

- Sequential SQL begins with 100 000 001.
- SQL statements that are extracted from DBRM modules are identified by the number 100 000 000 + the DBRM statement number.

The role of the SQL parser is to parse and store information about each query, such as the type and number of predicates, sort clauses, columns, and correlation names. This information is used later during the costing phase. The Explain-ready SQL statements are then passed to DB2 for evaluation by use of the EXPLAIN statement.

### Catalog Interface

The Catalog Interface component of DB2 SQL Performance Analyzer looks up the access paths that are chosen for each query, the tables and indexes involved, referential integrity relationships, space information, and other Explain data, and then disposes of the generic plan table entries with a mass delete.

DB2 SQL Performance Analyzer accesses the catalog for information about the table spaces, tables, indexes, keys, and relationships discovered by each access path, and retrieves critical size and cardinality data that are essential to the cost assessment process.

DB2 SQL Performance Analyzer accesses the catalog only once for each object sought, even if many queries are using the same tables or indexes in their access path. DB2 SQL Performance Analyzer stores the details about each object type in memory, and checks this information cache before attempting to access the catalog again. Catalog access is mainly confined to the SYSTABLESPACE, SYSTABLES, SYSINDEXES, SYSKEYS, SYSRELS, SYSCOLUMNS, SYSSYNONYMS, and SYSROUTINES tables.

## Resource estimator

The resource estimator component of DB2 SQL Performance Analyzer takes the parser and catalog information and determines the cost of each SQL statement.

The resource estimator determines costs by using its knowledge of the algorithms for the DB2 optimizer, and of the hundreds of benchmarked path lengths that represent the incremental costs of DB2 operations.

The costing module of the resource estimator determines a fully loaded cost for each query by using all of the intelligence data that is provided by the parser, the catalog sizing information in the catalog, and the evaluation techniques of the optimizer.

For example, the resource estimator calculates the filtering effects of each predicate in the WHERE clause to determine a final estimate of the number of rows retrieved. It also determines the portion of the data table and indexes that were accessed to provide these rows. In this processing, DB2 SQL Performance Analyzer mimics the algorithms of the optimizer and uses its costing methods to arrive at the estimate that is provided by DB2 SQL Performance Analyzer. The resource estimator is also sensitive to user and installation parameters, and can hypothesize and predict virtually any DB2 operational situation or environment that you can envision. DB2 SQL Performance Analyzer can also use the internal estimates of the optimizer for path length by using data from the DSN\_STATEMNT\_TABLE table.

## CAF features that enhance DB2 SQL Performance Analyzer

You can use the call attachment facility (CAF) to enhance how DB2 SQL Performance Analyzer functions.

**CAF** DB2 SQL Performance Analyzer uses the CAF to communicate with DB2 instead of using IKJEFT01 because CAF uses fewer resources.

DB2 SQL Performance Analyzer provides its own set of generic plan tables for collecting each user's transient Explain information, and provides a REGISTRY table to control contention and provide maximum concurrency. These tables are built under DB2 on the systems that DB2 SQL Performance Analyzer is installed on. The secondary authorization ID exit programs that are provided with DB2(DSN3@ATH and DSN3@SGN) are used to introduce a set of DB2 SQL Performance Analyzer secondary authorization IDs that own the set of DB2 SQL Performance Analyzer generic plan tables.

## Easy Explain

Easy Explain helps the DB2 application designer and programmer understand the access path that was selected by DB2 for a given SQL statement.

Easy Explain uses information that is produced by the SQL EXPLAIN statement and additional relevant DB2 catalog data.

Easy Explain can run in stand-alone mode or can be integrated with DB2 SQL Performance Analyzer. Easy Explain has been fully integrated into the TSO ISPF interface of DB2 SQL Performance Analyzer and is run with each SQL EXPLAIN statement that is performed. Easy Explain can also be run as a batch job. When Easy Explain is integrated, you can extract plans and packages from the DB2 catalog and present them to DB2 SQL Performance Analyzer for analysis. You can also store and compare before-and-after access plans and their costs.

Information that is produced by the SQL EXPLAIN function is useful in application design and tuning. However, the SQL EXPLAIN function information is not sufficient to determine and understand the access path that is chosen by DB2 and documented by the EXPLAIN function.



Typically, the application designer and programmer must extract DB2 catalog information to understand and validate the chosen access path.

The main purpose of Easy Explain is to combine information that is returned by the SQL EXPLAIN statement and information that is extracted from the DB2 catalog and to document that data in an understandable way.

Easy Explain accepts a query number of a previous EXPLAIN operation, the name of a plan that was bound with the EXPLAIN option, a QMF query, or any Data Manipulation Language (DML) statement. For a QMF query or a DML statement, Easy Explain explains the statement and provides an explanation of the selected access path. If the plan or package was not bound with the EXPLAIN option, Easy Explain performs a dynamic EXPLAIN of the DML SQL statements in the plan or package.

Using current EXPLAIN statement data as input to the DB2 SQL Performance Analyzer cost analysis provides you the opportunity to ensure that the DB2 catalog represents an accurate view of this application environment. For an application in the early stages of development, that view could be the projected production environment or it could represent a new indexing option that is being considered to boost the performance of an existing production application.

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## DB2 SQL Performance Analyzer architecture and process flow

DB2 SQL Performance Analyzer processes information from various input sources based on user and system parameters that you specify and then produces a series of reports that you use in your analysis.

DB2 SQL Performance Analyzer firsts reads and sets user and system-related parameters. After the parameters are read, DB2 SQL Performance Analyzer reads SQL statements. The source of the SQL statements can be any of the supported input sources, such as a single DBRM or a whole DBRM library, a PLAN or PACKAGE from the system catalog, SQL that is contained in a sequential or partitioned data set, or SQL that is embedded in source code. For each of the SQL statements, DB2 SQL Performance Analyzer determines if a plan exists. If a plan does not exist, DB2 SQL Performance Analyzer performs a DB2 PREPARE and EXPLAIN to create the necessary plan information. DB2 SQL Performance Analyzer then fetches the rows from various EXPLAIN tables for analysis, fetches the system catalog statistics that are associated with DB2 objects that are being analyzed, analyzes the information collected, and produces a number of reports.

The following figure shows the basic process flow for DB2 SQL Performance Analyzer.



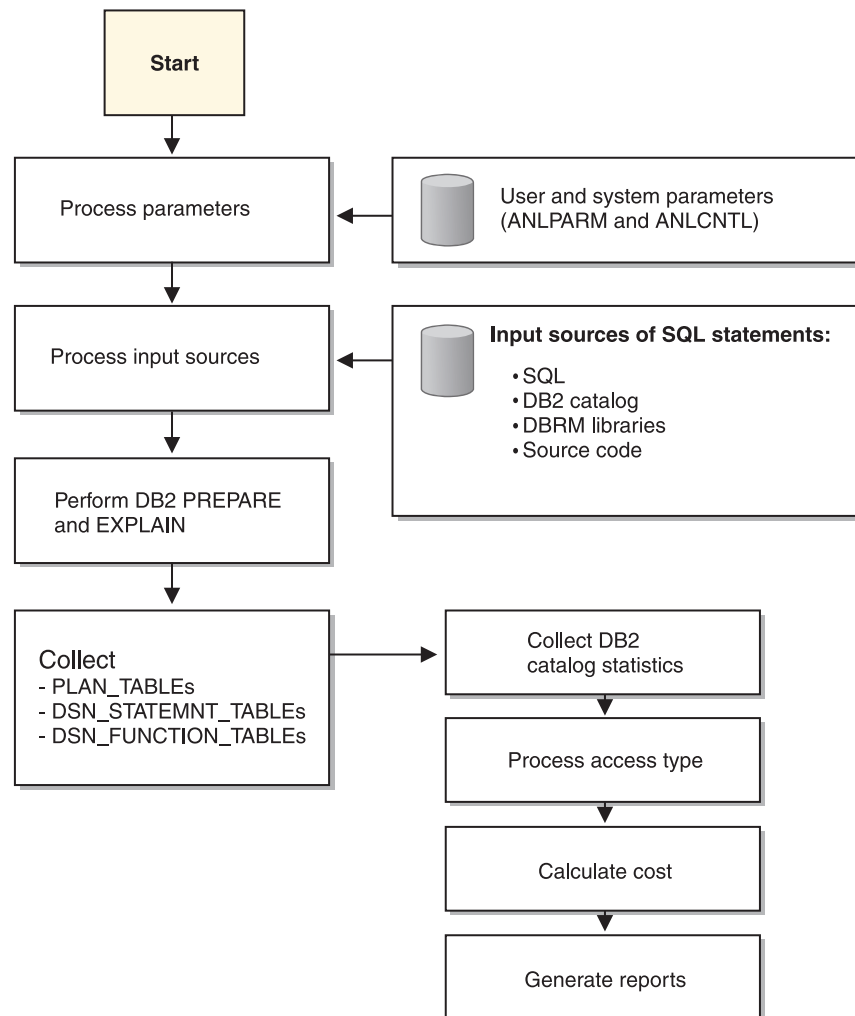


Figure 4. The DB2 SQL Performance Analyzer process

## DB2 SQL Performance Analyzer operating environments

DB2 SQL Performance Analyzer operates in four primary environments: batch, TSO, QMF, and as a stored procedure.

From the batch or TSO environment, DB2 SQL Performance Analyzer can evaluate queries that are targeted to run from any attach facility. You determine how your application's queries attach to DB2 by setting a user parameter that you supply to DB2 SQL Performance Analyzer. To evaluate how your application runs under the many versions of IMS or CICS, run DB2 SQL Performance Analyzer in batch mode to produce a series of reports that detail the forecasted performance of each query.

The same facilities that are available to users of DB2 SQL Performance Analyzer in batch mode are provided online under TSO. When you are designing an application, you can use DB2 SQL Performance Analyzer under TSO iteratively to refine the design of that application. With DB2 SQL Performance Analyzer under TSO, you also can target a few specific SQL statements from a file, and do a

detailed cost analysis on these. By using this method, you can examine the effects of various options in the design process. Similarly, you can examine large files of SQL statements or scan DBRM modules.

DB2 SQL Performance Analyzer under TSO and batch provides identical report formats. Therefore, if the system is busy, consider submitting a batch job; if you are fine-tuning an application, do it online in real time by using DB2 SQL Performance Analyzer under TSO.

In the QMF environment, DB2 SQL Performance Analyzer is designed to intercept ad hoc queries and notify you of their cost before processing. Its primary purpose is to identify long-running queries, and give you the opportunity to cancel them before they run.

You can cancel queries that exceed the guidelines for processor use, I/O use, and elapsed time. You can configure queries to be canceled automatically or at your discretion. You can also redirect long-running queries to QMF batch where they can run to completion. When queries are unrestricted by the governor process, you can obtain the results set that you want.

DB2 SQL Performance Analyzer does not intercept IMS or CICS transactions in flight because these systems do not have a common facility to present the cost and solicit a response to continue or cancel. However, IMS and CICS can call the WLM stored procedure (ANLPRCR), which provides a convenient way to govern virtually all DB2 applications, both dynamic and static SQL. You can call DB2 SQL Performance Analyzer as a stored procedure, and pass the SQL statement for evaluation. DB2 SQL Performance Analyzer returns the cost values, warning flags, and other information in real time, so that the application can decide whether to proceed with the query or try an alternative query.

DB2 SQL Performance Analyzer can parse and extract the relevant SQL statements from the DBRM modules that are created by the DB2 precompiler. A DB2 SQL Performance Analyzer cost analysis is then performed (either from TSO or batch mode), and even IMS- or CICS-related costs are included in the overall view of each query. For example, you can use DB2 SQL Performance Analyzer to evaluate an entire application system that is running on IMS to determine which SQL statements are likely to run the longest. You can then fine-tune those statements to enhance their performance. All valid methods of attaching to DB2 are supported by DB2 SQL Performance Analyzer, along with their individual attendant processor usage. The processor usage, including the path lengths of attaching to DB2, is available through private benchmarks.

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## **DB2 SQL Performance Analyzer documentation and updates**

This topic explains where to find DB2 Tools information on the Web, and explains how to receive information updates automatically.

### **DB2 SQL Performance Analyzer information on the Web**

The DB2 Tools Product publications Web page provides current product documentation that you can view, print, and download. To locate publications with the most up-to-date information, refer to the following Web page:

<http://www.ibm.com/software/data/db2imstools/db2tools-library.html>

IBM Redbooks publications that cover DB2 Tools are available from the following Web page:

<http://www.ibm.com/software/data/db2imstools/support.html>

## Receiving updates automatically

To automatically receive a weekly email that notifies you when new technote documents are released, when existing product documentation is updated, and when new product documentation is available, you can register with the IBM My Support service. You can customize the service so that you receive information about only those IBM products that you specify.

To register with the My Support service:

1. Go to <http://www.ibm.com/support/mysupport>
2. Enter your IBM ID and password, or create one by clicking **register now**.
3. When the My Support page is displayed, click **add products** to select those products that you want to receive information updates about. The DB2 and IMS Tools category is located under **Software > Data and Information Management > Database Tools & Utilities**.
4. Click **Subscribe to email** to specify the types of updates that you would like to receive.
5. Click **Update** to save your profile.



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## Chapter 5. Overview of IBM InfoSphere Optim Query Workload Tuner, Version 4.1.0.1

IBM InfoSphere Optim Query Workload Tuner helps database administrators and SQL developers optimize the performance of SQL statements in applications that query DB2 for Linux, UNIX, and Windows databases or that query DB2 for z/OS subsystems.

SQL optimization is critical to improving application performance. When SQL queries and workloads in applications are not tuned for optimal performance, application degradation can put revenue at risk, lower customer satisfaction, and increase infrastructure costs.

For a list of some of the scenarios in which query-workload tuning can be helpful and procedures that you can follow for each scenario, see Scenarios for fixing or comparing multiple access plans.

To learn how to do tasks that are related to tuning query workloads that run on DB2 for z/OS, see Tuning query workloads that run on DB2 for z/OS.

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### Product components for IBM InfoSphere Optim Query Workload Tuner, Version 4.1.0.1

IBM InfoSphere Optim Query Workload Tuner, Version 4.1.0.1 consists of two components: IBM Data Studio client, Version 4.1.0.1 and a license activation kit.

For full details about installing the product and activating the full set of tuning features on DB2 databases and subsystems, see Installing IBM InfoSphere Optim Query Workload Tuner, Version 4.1.0.1.

#### IBM Data Studio client, Version 4.1.0.1

The product package for InfoSphere Optim Query Workload Tuner includes the IBM Data Studio client, Version 4.1.0.1 and a license activation kit. If you plan to activate the full set of product features on DB2 databases or subsystems, you must install this client on your workstation, together with the license activation kit that is in the product package.

The client provides the full set of tuning features when you connect to a DB2 database or subsystem on which a license for InfoSphere Optim Query Workload Tuner is active.

However, if you try to tune SQL statements on a DB2 database or subsystem where the full set of tuning features for InfoSphere Optim Query Workload Tuner is not activated, the IBM Data Studio client restricts the set of features that you can use. With these *no-charge* features, you can format SQL statements so that they are easier to read, generate visual representations of access plans, and get recommendations for collecting statistics on the objects that a statement references. You can also generate a report that summarizes information about the access plan and includes the recommendations.

For a comparison of the no-charge features and the full set of features that are in InfoSphere Optim Query Workload Tuner, see Tuning features.

## License activation kit

The product package for InfoSphere Optim Query Workload Tuner, Version 4.1.0.1 contains either of these components:

- IBM InfoSphere Optim Query Workload Tuner for DB2 for Linux, UNIX, and Windows License Activation Kit, Version 4.1.0.1
- IBM InfoSphere Optim Query Workload Tuner for DB2 for z/OS License Activation Kit, Version 4.1.0.1

If you plan to activate the full set of tuning features on DB2 databases or subsystems, you must install on your workstation the license activation kit that is in your product package. The kit can be installed only on a workstation where the IBM Data Studio client, Version 4.1.0.1 is installed.

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## Tuning features

To use the full set of tuning features for InfoSphere Optim Query Workload Tuner on a DB2 database or subsystem, you must activate it. If you do not activate the full set of tuning features, however, you can use only a subset of those features.

### Default features for tuning SQL statements in the IBM Data Studio, Version 4.1.0.1 client

You can use these features in the IBM Data Studio client, Version 4.1.0.1 *whether or not* the full set of tuning features for InfoSphere Optim Query Workload Tuner is activated on the DB2 system where your SQL statements run.

- Capture the environment of single SQL statements; send representations of the environments to IBM Support or re-create the environments on another subsystem
- Create reports that summarize recommendations and information about database objects in access plans
- Create reports that summarize the statistics that the DB2 optimizer uses to create access plans
- Format SQL statements for better readability and analysis, and compare the formats of two different versions of an SQL statement or two different statements
- Generate RUNSTATS commands for fixing problems with statistics
- Generate visual representations of access plans for single SQL statements

### Tuning features that are included with InfoSphere Optim Query Workload Tuner

#### Features for tuning single SQL statements

You can use these features in the IBM Data Studio client, Version 4.1.0.1 *only if* the full set of tuning features for InfoSphere Optim Query Workload Tuner is activated on the DB2 system where your SQL statements run.

Table 2. Priced features for tuning single SQL statements.

Feature	InfoSphere Optim Query Workload Tuner DB2 for Linux, UNIX, and Windows	InfoSphere Optim Query Workload Tuner DB2 for z/OS
Annotate formatted SQL statements with statistics	✓	✓
Create, validate, and deploy optimization profiles to modify access plans directly	✓	
Drill down into the details of access plans with the Access Plan Explorer	✓	✓
Generate recommendations for creating indexes	✓	✓
Generate recommendations for improving access paths	✓	✓
Generate recommendations for rewriting SQL statements	✓	✓
Virtually test recommended indexes and indexes that you propose	✓	✓
Create, validate, and deploy plan hints to modify access plans directly		✓
Override the selectivity (filter factors) of predicates		✓ (DB2 11 for z/OS new-function mode only)

### Features for tuning query workloads

You can use these features in the IBM Data Studio client, Version 4.1.0.1 *only if* the full set of tuning features for InfoSphere Optim Query Workload Tuner is activated on the DB2 system where your SQL statements run.

Table 3. Priced features for tuning query workloads.

Feature	InfoSphere Optim Query Workload Tuner DB2 for Linux, UNIX, and Windows	InfoSphere Optim Query Workload Tuner DB2 for z/OS
Tune SQL statements that are captured from repositories in InfoSphere Optim Performance Manager	✓	✓
Generate recommendations and DDL for creating and modifying indexes	✓	✓
Generate RUNSTATS commands for fixing problems with statistics	✓	✓
Generate recommendations and DDL for creating or modifying statistical views	✓	

Table 3. Priced features for tuning query workloads (continued).

Feature	InfoSphere Optim Query Workload Tuner DB2 for Linux, UNIX, and Windows	InfoSphere Optim Query Workload Tuner DB2 for z/OS
Generate recommendations and DDL for MQTs, multi-dimensional clustering, and redistributing data across partitions	✓	
Generate recommendations and scripts for migrating row-organized tables to column-organized tables	✓	
Compare, annotate, and generate reports on the access plans and estimated cost changes for SQL statements in different packages or workloads		✓
Create reports on the catalog information for tables that SQL statements reference		✓
Generate recommendations for improving access paths		✓
Generate recommendations for rewriting SQL statements		✓
Capture the environments of query workloads; send representations of the environments to IBM Support or re-create the environments on another subsystem		✓
Generate recommendations for offloading tables to DB2 Analytics Accelerator		✓



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