How to Build Your Own DB2 Performance Database

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INTERNATIONAL DB2 USERS GROUP

Independent • Not-for-Profit • User Run

Agenda

- Bank of Montreal (**BMO Financial Group**)
- Introduction to DB2's Instrumentation Facility
- Building a DB2 Performance Database
- Reporting and Exception Monitoring
- Monitoring Key Performance Metrics
- Summary

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"**How to Build Your Own DB2 Performance Database**" is a practical implementation of a DB2 performance database using the DB2 Instrumentation Facility and DB2PM.

Monitor:

➤ User activity (accounting)

➤ System thresholds (statistics)

➤ Lock suspension/timeouts/deadlocks (locking)

➤ Audit table access (audit)

➤ Dynamic SQL, Sort information, Rid Pool details and Buffer Pool Statistics at the dataset level (performance traces)

➤ Set and monitor DB2 thresholds (exceptions)

➤ … AND much more!

Slide 1

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www.bmo.com

- **BMO Financial Group**
  - ❖ Bank of Montreal (*Canada's Oldest Bank!*)
  - ❖ Harris Bank (Chicago)
  - ❖ Nesbitt Burns (Investment Firm)
- "A Diversified Financial Services Institution"
- CDN$247 billion in assets
- 1,100+ Branches & 2,200+ ABMs
    Coast to Coast … 5 time zones
- 24 * 7 * 365 service
- Virtual banking … Internet, PC, Telephone
- Over 33,000 employees

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Slide 2

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System Environment

- **z/OS Environment**
  - 6 mainframes
    IBM zSeries
    8,000+ MIPS, 100+ GB memory
  - 4 Coupling Facilities
  - EMC, IBM, Hitachi, StorageTek DASD
  - StorageTek Automated Cartridge Silo
- **Open Systems**
  - IBM AIX/SP2
    Production Applications
    Information Warehouse and Datamarts
    DB2 Connect Servers

Software Configuration

- **DBMSs**
  - DB2 UDB for z/OS V7
  - DB2 UDB EEE (AIX/SP2) V7.2 and V8.1
  - DB2 UDB for Windows/NT
  - IDMS
  - Oracle, Sybase
  - MAAS (homegrown!)
  - … and LOTS of VSAM
- **DB2 for z/OS Production Environment**
  - 5 DB2 Data Sharing Groups: 4-way or 5-way
  - 5 DB2 Subsystems
  - 8 GigaBytes of Bufferpools
  - 2 TeraBytes of DB2 Data
  - 70+ applications
  - 12 (24*7*365) mission critical applications
      e.g. MasterCard, Online Banking

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About Us

BMO FINANCIAL GROUP http://www.bmo.com

Beginning in 1817, BMO Financial Group (NYSE, TSX: BMO) is one of the largest financial services providers in North America. With average assets of $247 billion as at July 31, 2002 and more than 33,000 employees, BMO provides a broad range of retail banking, wealth management and investment banking products and solutions. BMO serves clients across Canada and in the United States through its Canadian retail arm BMO Bank of Montreal, Chicago-based Harris Bank, a major U.S. mid-west financial services organization which also has wealth management offices and branches across the United States and BMO Nesbitt Burns, one of North America's leading full-service investment firms.

The History of Bank of Montreal

Bank of Montreal, Canada's first chartered bank, opened for business on November 3rd, 1817. It provided Canada's first sound and plentiful currency and has played a major and continuing role in the development of the country, taking part in the financing of the first transcontinental railway in the 1880s. The Bank took part in the creation of Canadian Confederation in 1867 and served as Canada's central bank until 1935. The first Canadian bank to open branches abroad, it has long been active in European, Latin American, and East Asian markets as well as in the United States. Today it continues as one of Canada's pre-eminent financial institutions and has a significant presence in United States and world markets.

About Harris Bank: visit http://www.harrisbank.com/facts.html

About BMO Nesbitt Burns: visit http://www.bmonesbittburns.com

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The six mainframes are carved out into multiple logical sites. All multi-LPAR sites have been defined as SYSPLEXes.

In the Open Systems environment, IBM's SP2/AIX operating system is the predominant and the Bank's strategic platform. The Bank is currently running production applications, the Information Warehouse, some Datamarts, and the DB2 Connect servers on the SP2 environment.

Today, the Bank's network is a combination of SNA and TCP/IP.

The "Development" environment is also the Bank's contingency "Disaster Recovery" site. Most of the offsite data for DR is transmitted electronically to the remote site using NDM (Network Data Mover) software and T3 network links. The remaining DR data is remotely mirrored using Hitachi's TrueCopy technology.

The Bank's standard DBMS platform is DB2 UDB for both z/OS and the open systems SP2/AIX environments.

Today approximately 50% of the production "databases" on z/OS are DB2… the majority of the remaining "databases" are VSAM. The Bank has a very large database using a homegrown DBMS (called MAAS) that has been around for 25years! And remnants of IMS and IDMS databases.

In the Open Systems environment the majority of the production databases are DB2 UDB EEE. Other DBMS in this environment include, DB2 UDB for Windows/NT, Oracle and Sybase.

The Bank's standard Transaction Manager is CICS, and it's standard messaging software is MQSeries.

There are 25+ DB2 subsystems and DB2 Data Sharing members at the Bank, supporting over 70 DB2 production applications. Many of these applications are mission critical… 12 have 24*7*365 availability today (or close to it!!) and most have a requirement for continuous availability.

There are 5 production DB2 Data Sharing Groups at the Bank. The strategy is to have a DB2 data sharing group member on each LPAR (Logical Partition). Most of the Bank's DB2 applications are on, or are migrating to DB2 Data Sharing groups. The applications not scheduled for DB2 data sharing are on 5 DB2 Subsystems (primarily because they reside on single image LPARS). The only exception to this rule is our PeopleSoft DB2 subsystem (data sharing for this subsystem is being considered).

The DB2 production environment consists of approximately 2 TeraBytes of DB2 data and utilizes approximately 8 GigaBytes of memory for bufferpools (all virtual pools).

The Development environment consists of 3 DB2 Data Sharing Groups. All groups consist of two members most of the time, but have the capability of running with four members… to simulate the production environment during QA or volume testing. There are also 5 DB2 Subsystems in the development environment. All DB2 development subsystems and members utilize approximately 3 GigaBytes of memory for bufferpools (all virtual pools).

Introduction to…
DB2's Instrumentation Facility

- Overview
- What is an IFCID?
- DB2 Trace Types and Classes
- Reporting methods
- How to format an IFCID

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This section will cover DB2's Instrumentation Facility (IF).

After an overview and definition of DB2's Instrumentation Facility, this section will… define what an IFCID is; it will describe the various traces (and it's types and classes) … and finally, it will discuss various methods for reporting the trace data, including how to format an IFCID!

Instrumentation Facility
Overview

- Instrumentation Facility (IF) is a component of DB2's System Services Address Space [DSNMSTR]
- Instrumentation Facilities component <u>services</u> include:
  - DUMP services
  - **TRACE services**
    - Collects Accounting and Statistical information
    - Provides Performance and Serviceability TRACE data
    - Controls TRACE execution
    - Manages the Instrumentation Facility Interface (IFI)
    - TRACE can be activated automatically at DB2 startup or manually by the DB2 -START TRACE command

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DB2's Instrumentation Facility (IF) is a component of DB2's System Services Address Space [DSNMSTR]. The Instrumentation Facilities (IF) subcomponent provides TRACE and DUMP services. DUMP services will not be covered in this presentation.

TRACE services provides a facility to record DB2 data and events …

- ➢ Collects Accounting and Statistical information
- ➢ Provides Performance and Serviceability trace data
- ➢ Controls TRACE execution
- ➢ Manages the Instrumentation Facility Interface (IFI). The IFI is designed for programs needing online trace information (i.e. Online Performance Monitor)
- ➢ TRACE can be activated automatically at DB2 startup or manually by the DB2 –START TRACE command

Instrumentation Facility
What is an IFCID?

IFCID = **I**nstrumentation **F**acility **C**omponent **ID**entifier

- Each TRACE event has a specific format and Instrumentation Facility Component Identifier - **IFCID**
- An IFCID uniquely identifies a DB2 TRACE event
- IFCIDs can be activated by either the -START TRACE command or automatically at DB2 startup
- There are 220+ IFCIDs
- DB2's DSNSAMP(DSNWMSGS) library contains descriptions of all trace IFCIDs
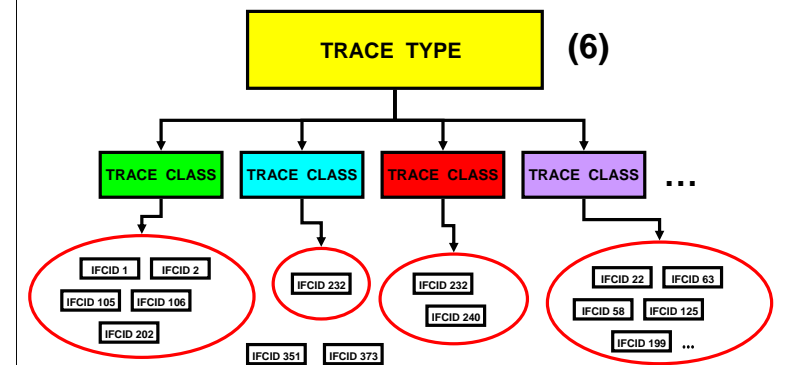
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Instrumentation Facility
DB2 Trace Types and Classes

TRACE TYPE (6)

TRACE CLASS   TRACE CLASS   TRACE CLASS   TRACE CLASS   ...

IFCID 1 IFCID 2
IFCID 105 IFCID 106
IFCID 202

IFCID 232

IFCID 232
IFCID 240

IFCID 22 IFCID 63
IFCID 58 IFCID 125
IFCID 199 ...

IFCID 351 IFCID 373

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What is an IFCID?   An IFCID is an "**I**nstrumentation **F**acility **C**omponent **ID**entifier" and it uniquely identifies a DB2 TRACE event. Each TRACE event has a specific format and Instrumentation Facility Component Identifier (IFCID).

IFCIDs can be activated by either the –START TRACE command or automatically at DB2 startup.

Today (DB2 V7) there are over 220 IFCIDs … and growing with every release!

IFCID trace descriptions can be found in *prefix*.DSNSAMP(DSNWMSGS); IFCIDs are also described by the comments in their mapping macros, contained in *prefix*.SDSNMACS. Both datasets are shipped with DB2. Check with your System Programmer if you can't find these datasets, or you don't have access to them.

DB2 Instrumentation Facility TRACE events and data are grouped into trace **TYPES** and trace **CLASSES**.
There are 6 trace TYPES:
- **Accounting** - application program information
- **Statistics** - DB2 system services information
- **Audit** - DB2 security controls
- **Performance** - variety of DB2 events
- **Monitor** - data for online monitoring
- **Global** - IBM serviceability data

Trace CLASSES:
- A CLASS defines a certain group of events or data within a trace TYPE
- A trace CLASS contains at least 1 IFCID, but usually contains multiple IFCIDs
- Most IFCIDs are grouped into CLASSES … and some IFCIDs may be found in multiple CLASSES

Instrumentation Facility
DB2 Trace Types and Classes

Trace Type	Trace Classes
Accounting [SMF 101]	1-3, 5, 7-8; 4 [installation defined]; 6, 9-29 [reserved]; 30-32 [available for local use]
Statistics [SMF 100 + 102]	1, 3-6, 8; 2 [installation defined]; 7, 9-29 [reserved]; 30-32 [available for local use]
Performance [SMF 102]	1-14, 16-17, 20-22; 15 [installation defined]; 18-19, 23-29 [reserved]; 30-32 [available for local use]
Audit [SMF 102]	1-8; 9 [installation defined]; 10-29 [reserved]; 30-32 [available for local use]
Monitor	1-3, 5-8; 4 [installation defined]; 9-29 [reserved]; 30-32 [available for local use]

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This chart shows the available trace TYPEs (except for the GLOBAL trace) and their corresponding trace CLASSES. For a description of each trace class … refer to the –START TRACE command in the DB2 for z/OS Command Reference manual.

Note that trace classes 30-32 for all trace types are available for local use … more on this later!

This chart also shows the SMF record type for the various trace types when DESTination is SMF:

- **Accounting** - **SMF 101**: IFCIDs: 3 (Agent Accounting) *
                                 239 (Agent Accounting Overflow)

- **Statistics** - **SMF 100**: IFCIDs: 1 (System Services Statistics)
                                 2 (Database Services Statistics)
                             202 (dynamic System Parameters)
                             230 (Data Sharing Global Statistics)
              - **SMF 102**: All other IFCIDs

- **Performance** - **SMF 102**: All IFCIDs

- **Audit** - **SMF 102**: All IFCIDs

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* Accounting data for class 1 is accumulated by several DB2 components during normal execution. This data is then collected at the end of the accounting period (thread termination); it does not involve as much overhead as individual event tracing.
On the other hand, when you start class 2,3,7, or 8, many additional trace points are activated. Every occurrence of these events (IFCIDs) is traced internally by DB2 trace, however, these traces are not written to any external destination. Rather, the accounting facility use these traces to compute the additional total statistics that appear in the accounting record … IFCID 003, when class 2 or class 3 is activated. Accounting class 1 must be active to externalize the information.
Reference: DB2 for z/OS Administration Guide

Instrumentation Facility
DB2 Trace Types and Classes

Trace Type	TRACE CLASS	DESCRIPTION	IFCID
Accounting	1	STANDARD ACCOUNTING DATA	3 106, 239
	2	ENTRY OR EXIT FROM DB2 EVENT SIGNALLING – "in-DB2" Time	232
Statistics	3	ELAPSED WAIT TIME IN DB2	6-9, 32-33, 44-45, 117-118, 127-128, 170-171, 174-175, 213-216, 226-227, 242-243, 321-322,329
Performance	5	TIME SPENT PROCESSING IFI REQUESTS	187
Audit	7	ENTRY OR EXIT FROM DB2 EVENT SIGNALLING FOR PACKAGE AND DBRM ACCOUNTING – "in-DB2" Time	232, 240
Monitor	8	WAIT TIME FOR A PACKAGE	6-9, 32-33, 44-45, 117-118, 127-128, 170-171, 174-175, 213-216, 226-227, 241-243, 321-322

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Instrumentation Facility
DB2 Trace Types and Classes

Trace Type	TRACE CLASS	DESCRIPTION	IFCID
Accounting	1	STATISTICS DATA	1, 2, 105-106, 202
	3	DEADLOCK, GROUP BUFFER POOL, DATA SET EXTENSION INFORMATION, AND INDICATIONS OF LONG-RUNNING URs AND ACTIVE LOG SPACE SHORTAGES	172, 196, 250, 258, 261-262, 313, 330, 337
Statistics			
Performance	4	DB2 EXCEPTIONAL CONDITIONS	191-195, 203-210, 235-236, 238, 267, 268
	5	DB2 DATA SHARING STATISTICS RECORD	230
Audit	6	STORAGE USAGE DETAILS	225
Monitor	8	DATA SET I/O STATISTICS	199

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Instrumentation Facility
DB2 Trace Types and Classes

Trace Type	TRACE CLASS	DESCRIPTION	IFCID
Accounting	3	SQL EVENTS	22, 53, 55, 58, 59-62, 63, 64-66, 92, 95-96, 106, 112, 177, 233, 237, 250, 272-273, 325
Statistics	4	READS TO AND WRITES FROM THE BUFFER AND EDM POOLS	6-10, 29-30, 105-107, 127-128, 226-227, 321-322
	8	DATA SCANNING DETAIL	13-17, 18, 105-107, 125, 221-222, 231, 305, 311
Performance	9	SORT DETAIL	26-28, 95, 96, 106
Audit	16	DISTRIBUTED PROCESSING	157-163, 167, 183
Monitor	20	DATA SHARING COHERENCY SUMMARY	249-251, 256-257, 261-262, 267-268
	21	DATA SHARING COHERENCY DETAIL	255, 259, 263

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Instrumentation Facility
## Reporting Methods

- DB2 Traces are activated by the –START TRACE command …
    - **-START TRACE(PERFM) CLASS(30) IFCID(22,63,96,125) DEST(SMF)**
      PLAN(QMFPLAN) AUTHID(JBORGES) …
- Trace data can be written to SMF, GTF, MVS OS dataset or Instrumentation Facility Interface (usually used by online monitors)
- IF component provides a trace facility to record DB2 data and events, however analysis and reporting of the trace records must take place outside of DB2
- Use DB2PM (or similar product) to …
    - View trace data online
    - Format, print and interpret DB2 trace output
    - Generate files [which may be loaded into DB2 tables] ✓
- **Or**, format trace data using your own program…

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Instrumentation Facility
How to format an IFCID

- Formatting trace data using your own program!
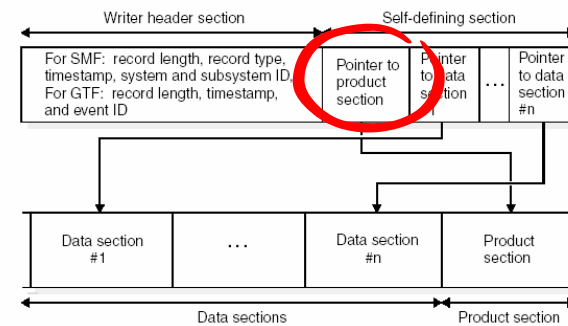
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Trace records contain up to four basic sections:
- An SMF or GTF writer header section
- A self-defining section
- A product section
- Zero or more data sections

The writer header section begins at the first byte of the record and continues for a fixed length. Writer headers for "statistics" records (SMF type 100) are mapped by macro DSNDQWST, for "accounting" records (SMF type 101) by macro DSNDQWAS, and for "performance", "audit" and "monitor" (SMF type 102) by macro DSNDQWSP. When these macros are assembled, they include the other macros necessary to map the remainder of the trace records sent to SMF.

The self-defining section follows the writer header section. The first self-defining section always points to a special data section called the product section. Among other things, the product section contains an instrumentation facility component identifier (IFCID). Descriptions of the records differ for each IFCID… the table on the following foil shows the mapping macros for the various IFCIDs.

Instrumentation Facility
How to format an IFCID

- Use assembler mapping macros in SDSNMACS to interpret DB2 trace records

IFCID	Mapped by Macro
0001	DSNDQWST, subtype=0
0002	DSNDQWST, subtype=1
0003	DSNDQWAS
0004 – 0057	DSNDQW00
0058 – 0139 (except 0106)	DSNDQW01
0106	DSNDQWPZ
0140 – 196, 198, 199	DSNDQW02
0201 – 0249 (except 202, 230 and 239)	DSNDQW03
0202	DSNDQWS2, subtype=2
0230	DSNDQWST, subtype=3
0239	DSNDQWAS and SNDQWA1
0250 – 0330	DSNDQW04

See "Interpreting DB2 Trace Output"
Appendix D - DB2 Administration Guide Volume 2

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To interpret a record … find its description (by IFCID) in one of the provided mapping macros.
For example: Macro **DSNDQWST** (subtype 1) maps out IFCID 2 - Database Services Statistics

Building a DB2 Performance Database (PDB)

- Benefits
- Data Sources
- Data Extraction
- Database Structure
  - Accounting
  - Statistics
  - Performance trace (IFCIDs) (Rid Pool, Sort, Locking, etc)
  - Exception
  - Business Metrics
- Data Summarization/Aggregation
- Data Retention

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Building a DB2 PDB …
Benefits

- Pro-Active Monitoring
  - Alerts
  - Triggers
  - Prevent problems <u>before</u> they happen!
- Automation
  - Increases efficiency
- Data Available to <u>everyone</u>!
  - Resulting in better performing applications
- A <u>MUST</u> for Capacity Planning
  - DB2 subsystem
  - Application

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Building a DB2 PDB …
Data Sources

- SMF
  - Accounting (Classes 1,2,3,7,8)
  - Statistics (Classes 1,2,4,5,6,8)
  - Performance trace (various IFCIDs)
- DB2PM Batch Reporter
  - Exceptions
- Miscellaneous Sources
  - Other PDBs (e.g. CICS, RMF, MQSeries, …)
  - Application/Business metrics

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Building a DB2 PDB …
Data Extraction

- Use DB2PM (or similar program) to extract DB2 trace data into files
  - Accounting
  - Statistics
  - Performance trace
- Use DB2PM to create DB2 "Exceptions" file
- Load extracted data into DB2 PDB

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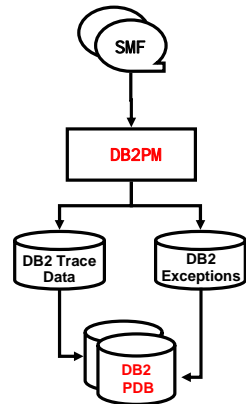
Building a DB2 PDB …
Database Structure

- DB2 PDB is made up of 3 main components

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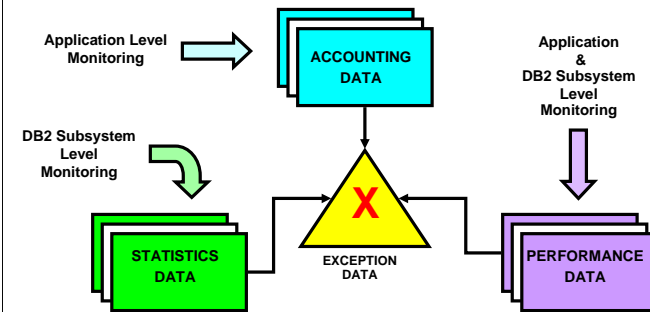
Building a DB2 PDB …
Database Structure

- DB2 PDB – Accounting Data component

ACCOUNTING Package

ACCOUNTING BufferPool

ACCOUNTING DDF

ACCOUNTING

Detail
Interval (e.g. 10 minutes)
Summary (e.g. 1 month)

ACCOUNTING Group BufferPool

ACCOUNTING RLF

X
EXCEPTION DATA
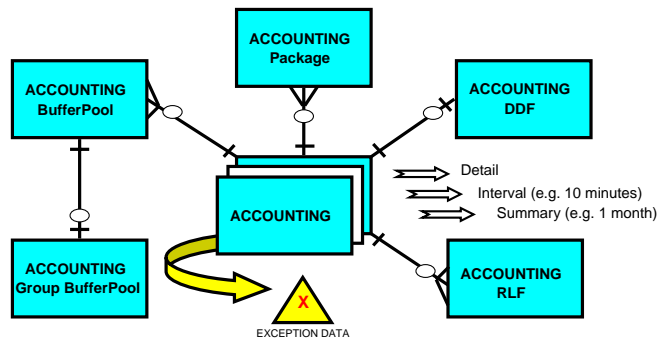
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Building a DB2 PDB …
Database Structure

- DB2 PDB – Statistics Data component

STATISTICS DataSet

STATISTICS BufferPool

STATISTICS DDF

STATISTICS

Interval (eg. 10 minute)
Daily Summary
Monthly Summary

STATISTICS Group BufferPool

X
EXCEPTION DATA
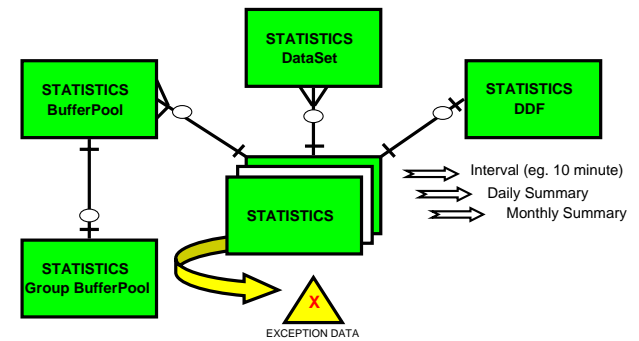
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Building a DB2 PDB …
Database Structure

- DB2 PDB – Performance Data component

PERFORMANCE LOCKING	PERFORMANCE IFCID 022	PERFORMANCE IFCID 063

X
EXCEPTION DATA

PERFORMANCE IFCID 096	PERFORMANCE IFCID 125	PERFORMANCE IFCID ???
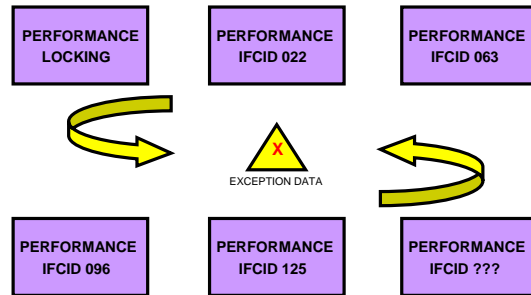
Building a DB2 PDB …
Data Summarization/Aggregation

- Summarization may occur at EXTRACTION time
  - DB2PM interval summarization (e.g. Accounting_Interval)
- Otherwise …
  Summarization and/or Aggregation occurs after the data is loaded into the DB2 PDB

  Two Methods:
  1) SQL queries
  2) Triggers

DB2 Trace Data

DB2 Exceptions

LOAD

Summ. Aggr.
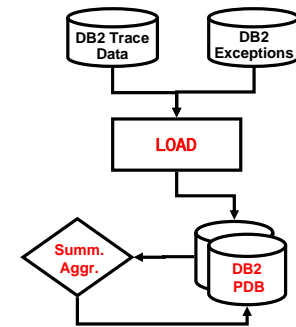
DB2 PDB

Building a DB2 PDB …
Data Retention

- **Detail data**
  - **Accounting**
    - as needed … then delete
  - **Statistics**
    - 550 days (6 quarters)
  - **Performance**
    - as needed … then delete
  - **Exceptions**
    - 365 days (1 year)

- **Summary data**
  - **Accounting**
    - 10 minute interval - 550 days (6 quarters)
    - monthly summary/aggregation - 10 years +
  - **Statistics**
    - daily summary - 5 years
    - monthly summary/aggregation - 10 + years

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Reporting and Exception Monitoring

- Build Your Own Reports
- Historical Trending
- Exception Monitoring
  - Set Your Thresholds
  - Set off Alerts and Trigger Actions
- Adhoc Reporting
- Sample Reports

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Reporting & Exception Monitoring
Build Your Own Reports

- Now that your DB2 PDB is a relational database, you have many choices of tools to **"Build Your Own Reports"!**
  - QMF, spreadsheets, GUI tools, Web … or your favourite report writer
- Tailor reports to suit your needs and requirements
- Report on…
  - Key performance metrics
  - Historical trends
  - Exceptions
  - Bottlenecks
  - Adhoc
  - Etc…

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Reporting & Exception Monitoring
Historical Trending

1) Statistics: DBM1 Storage Trend … **(IFCID 225) STATS CLASS(6)**

```
QUERY:    Select date, interval, available_storage, getmained_storage,
              virtual_bufferpool
          from wlz.db2_stat_intrvl
          Where local_location = 'dbga' and member = 'dba1'
          and date between '2002-07-10' and '2002-07-16'

                              AVAILABLE   GETMAINED     VIRTUAL
          DATE        INTERVAL   STORAGE     STORAGE   BUFFERPOOL
          ----------  --------  ----------  ----------  -----------
          2002-07-10  14.31.44  902848512   607201096   514048000
          2002-07-11  14.34.03  897490944   610728552   514048000
          2002-07-12  14.31.44  892841984   612335784   514048000
          2002-07-13  14.38.03  885747712   616972456   514048000
          2002-07-14  14.35.52  887836672   613703848   518144000
          2002-07-15  14.35.21  882028544   619028648   518144000
          2002-07-16  14.33.39  850505728   642920616   542720000
```

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```
SELECT A.DATE
        , A.PRIMAUTH
        , SUM (CASE WHEN SUBSYSTEM_ID=' DBA1'
                        THEN   (CLASS1_CPU_NNESTED)/60 * 13.42
                        WHEN SUBSYSTEM_ID=' DBA2'
                        THEN   (CLASS1_CPU_NNESTED)/60 * 13.67
                        WHEN SUBSYSTEM_ID=' DBA3'
                        THEN   (CLASS1_CPU_NNESTED)/60 * 14.02
                END)                                    AS CLASS1_CPU
        , SUM (CASE WHEN SUBSYSTEM_ID=' DBA1'
                        THEN   (CLASS1_CPU_NNESTED)/60 * 13.42
                        WHEN SUBSYSTEM_ID=' DBA2'
                        THEN   (CLASS1_CPU_NNESTED)/60 * 13.67
                        WHEN SUBSYSTEM_ID=' DBA3'
                        THEN   (CLASS1_CPU_NNESTED)/60 * 14.02
                END) / SUM(COMMIT)                      AS CPU_PER_COMMIT
        , SUM (COMMIT)                                  AS COMMIT
        , SUM (SELECT + INSERT + UPDATE + DELETE + DESCRIBE_TABLE
                        + DESCRIBE + PREPARE + OPEN + FETCH + CLOSE )   AS DML_SQL
-------------------------------------------------------------------------------
  FROM   WIZ.DB2_ACCT_INTRVL A
-------------------------------------------------------------------------------
WHERE    A.DATE         BETWEEN '2002-01-01' AND '2003-01-31'
        AND   A.LOCAL_LOCATION     = 'DBGA'
        AND   A.SUBSYSTEM_ID       IN ('DBA1','DBA2','DBA3')
        AND   A.CONNECT_ID         IN ('CICS006','CICS006B','CICS006C')
        AND   A.PRIMAUTH           IN ('ENRQ')
-------------------------------------------------------------------------------
GROUP BY A.DATE, A.LOCAL_LOCATION,
                 A.PRIMAUTH
```

NOTE: CPU converted to Model 200E

Reporting & Exception Monitoring
Historical Trending

3) Accounting: Online Application – Workload Trend (graph)
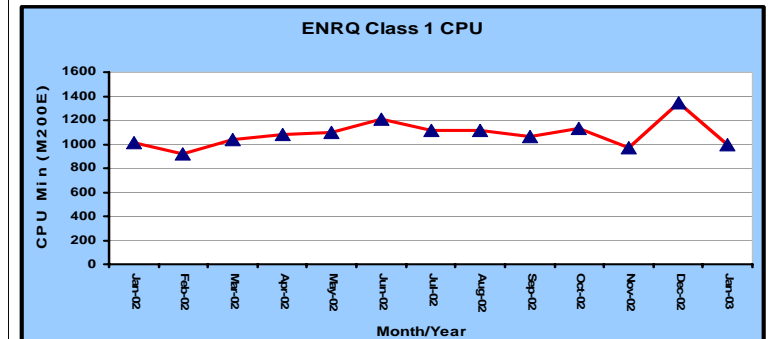
ENRQ Class 1 CPU

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Reporting & Exception Monitoring
Exception Monitoring

- Set Your Threshold Values and Build Queries to monitor … it's that easy!
- Automate monitoring process
- When threshold values are exceeded … fire off an alert and trigger corrective action!!

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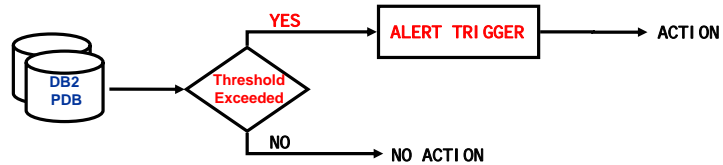
Reporting & Exception Monitoring
Exception Monitoring

1) **Accounting I/O Response Exception**: Average I/O > 20 ms

```
QUERY:  select interval, plan, primauth as txid, db_io,
               class3_db_io / db_io as avg_io_resp
        from wiz.db2_acct_intrvl
        Where date = '2002-12-23' and connect_id = 'clcs006'
               and (class3_db_io / db_io) > 0.020 and db_io > 0

                                                   AVG
          INTERVAL  PLAN       TXID      DB IO     IO RESP
          --------  --------   -----     --------  --------
          21.30.00  PLNCC      NCAL           13   0.0784
          03.20.00  PLNCC      NSIV           16   0.0484
          14.00.00  PLNCC      NA1D           46   0.0363
          23.20.00  PLNCC      SAPR            5   0.0313
          14.30.00  PLNCC      NEFL            2   0.0258
```

International DB2 Users Group

Reporting & Exception Monitoring
Exception Monitoring

2) EDM Pool Statistics Exception: EDM Pool Full

```
QUERY:  select date,interval,local_location,member_name,fail_pool_full
        from wiz.db2_stat_intrvl
        Where fail_pool_full > 0 and date >= '2002-07-01'
```

		LOCAL	MEMBER	FAIL
DATE	INTERVAL	LOCATION	NAME	POOL-FULL
----------	--------	--------	------	---------
2002-07-15	20.32.20	DBG0	DB02	17
2002-07-18	23.05.43	DBG0	DB01	10
2002-08-09	10.50.04	DBGB	DBB4	5
2002-08-30	11.58.09	DBGB	DBB2	35
2002-08-30	12.08.08	DBGB	DBB2	147
2002-08-30	12.18.09	DBGB	DBB2	8

International DB2 Users Group

Reporting & Exception Monitoring
Exception Monitoring

3) EXCEPTION Table: Check Exceptions Daily!

```
QUERY:  select db2id, instance, field_event, description,
        compare_basis, op, excp_value, thresh_value, excp_lvl
        from wiz.db2_exceptions
        where local_location = 'dbga' and date = '2002-12-23'
```

DB2ID	INSTANCE	FIELD EVENT	DESCRIPTION	COMPARE BASIS	OP	EXCP VALUE	THRESH VALUE	EXCP LVL
-----	------------	-----	--------------------------------	-------	--	-----------	-------	----
DBA1	B8B8B4F8E50B	PLAN	TOTAL CLASS 3 SUSPENSIONS	M	>	215	180	W
DBA1	B8B8B4F9E8AE	PLAN	TOTAL CLASS 3 SUSPENSIONS	M	>	583	240	P
DBA1	B8B8B4D04017	PLAN	GETPAGES PER SYNCRONOUS READ I	V	<	1	2	W
DBA3	B879BAB57D7D	SYST	ROWS IN MESSAGE BUFFER	V	<	0	1	P
DBA1	B8B8B4FE7424	PLAN	SERV.TASK SWITCH SUSP. TIME (C	M	>	22.929666	7	P
DBA1	B8B8B4FFBD59	PLAN	SERV.TASK SWITCH SUSP. TIME (C	M	>	5.279576	5	W
DBA1	B8B8B51F2F15	PLAN	RID LIST TERMINATED - ANY REAS	V	>	2	0	P
DBA3	B8B8AEA4C598	PLAN	GETPAGES	V	>	3714849	200000	P
DBA1	B89D7A78CCD2	SYST	TOTAL SQL DDL STATEMENTS	V	>	3	0	P
DBA1	B89D7A78CCD2	SYST	RID LIST NOT USED - ANY REASON	V	>	1	0	P

International DB2 Users Group

Reporting & Exception Monitoring
Adhoc Reporting

"Who has used QMF in the last 3 months, and how frequently?"

```
QUERY:   Select plan, primauth, count(distinct date) as frequency_days
         from  
         
                                                    rrent date
         
         order by 3 desc
```

Adhoc Report

```
PLAN                 FREQUENCY               FREQUENCY
NAME      PRIMAUTH   (DAYS)     PRIMAUTH     (DAYS)
--------  --------   ---------  --------    ---------
QMFPLAN   C5889DR        90     P8094UL         41
          DTOMPKI        88     M8OO7D1         39
          AJWHITE        47     JHONG           37
          JANICEA        45     C4O64PC         35
          T5936JR        43     DBABA           35
```

International DB2 Users Group

Monitoring KEY Performance Metrics

- Key Performance Metrics
  - Accounting
  - Statistics
- Key Performance IFCIDs
  - Dynamic SQL
  - Explain
  - RID Pool
  - Sort
  - and many more...

International DB2 Users Group

Monitoring KEY Performance Metrics
Key Performance Metrics

- **Accounting:** IFCID003
  - Most commonly used DB2 trace record
    - Perform program related tuning
    - Charge DB2 costs
  - Trace record written at thread termination
  - Accounting traces provide information at the application level…

  > **Elapsed time, CPU time, Wait time and counts, SQL events, Buffer Pool metrics, Locking, Data Sharing information, Package level metrics, etc…**

International DB2 Users Group

```
         LOCATION: DBGA                    DB2 PERFORMANCE MONITOR (V7)           DB2 VERSION: V7
            GROUP: SCADBGA                    ACCOUNTING TRACE - LONG
           MEMBER: DBA1

 ---- IDENTIFICATION ---------------------------------------------------------------------------
 ACCT TSTAMP: 07/04/02 02:01:54.00   PLANNAME: PLNCC        WLM SCL: 'BLANK'       CICS NET: 'BLANK'
 BEGIN TIME : 07/04/02 01:44:17.21   PROD ID : N/P                                 CICS LUN: 'BLANK'
 END TIME   : 07/04/02 02:01:54.00   PROD VER: N/P          LUW NET: NETMECH       CICS INS: 000000000000
 REQUESTER  : DBGA                    CORRNAME: EPOI         LUW LUN: SCADBA1
 MAINPACK   : CSUTO9O4                CORRNMBR: POOL         LUW INS: B7DFCFCO4A73  ENDUSER : 'BLANK'
 PRIMAUTH   : EPOI                    CONNTYPE: CICS         LUW SEQ:           1   TRANSACT: 'BLANK'
 ORIGAUTH   : EPOI                    CONNECT : CICSOO6                             WSNAME : 'BLANK'

 MVS ACCOUNTING DATA  : 'BLANK'
 ACCOUNTING TOKEN(CHAR): N/A

 ELAPSED TIME DISTRIBUTION                              CLASS 2 TIME DISTRIBUTION
 -----------------------------------------             ----------------------------------
 APPL     >=====> 10%                                  CPU     >===> 7%
 DB2      >====> 8%                                    NOTACC  >=> 2%
 SUSP     >========================================> 82%   SUSP >====================================> 91%

 TIMES/EVENTS  APPL(CL.1)  DB2 (CL.2)  IFI (CL.5)   CLASS 3 SUSPENSIONS  ELAPSED TIME  EVENTS  HIGHLIGHTS
 -----------   ----------  ----------  ----------   -----------------   ------------  ------  --------------------
 ELAPSED TIME  16:36.7888  15:54.1410      N/P      LOCK/LATCH(DB2+IRLM)  2:42.147920    2905  THREAD TYPE  : ALLIED
   NONNESTED   16:36.7888  15:54.1410      N/A       SYNCHRON. I/O       1:37.970261   11808  TERM.CONDITION: NORMAL
   STORED PROC  0.000000    0.000000      N/A        DATABASE I/O       1:33.620410   11645  INVOKE REASON : DEALLOC
   UDF          0.000000    0.000000      N/A        LOG WRITE I/O         4.349851     163  COMMITS      :        1672
   TRIGGER      0.000000    0.000000      N/A       OTHER READ I/O        1.836027      97  ROLLBACK     :           0
                                                    OTHER WRTE I/O        0.000000       0  SVPT REQUESTS :          0
 CPU TIME      11.77672   1:03.94734      N/P      SER.TASK SWTCH        51.070366    1666  SVPT RELEASE :           0
   AGENT       11.77672   1:03.94734      N/A       UPDATE COMMIT        51.070366    1666  SVPT ROLLBACK :          0
   NONNESTED   11.77672   1:03.94734      N/P       OPEN/CLOSE            0.000000       0  INCREM.BINDS :           0
   STORED PRC   0.000000    0.000000      N/A       SYSLGRNG REC          0.000000       0  UPDATE/COMMIT :       8.76
   UDF          0.000000    0.000000      N/A       EXT/DEL/DEF           0.000000       0  SYNCH I/O AVG. :   0.008297
   TRIGGER      0.000000    0.000000      N/A       OTHER SERVICE         0.000000       0  PROGRAMS     :           9
   PAR.TASKS    0.000000    0.000000      N/A      ARC.LOG(QUIES)         0.000000       0  MAX CASCADE  :           0
                                                   ARC.LOG READ          0.000000       0  PARALLELISM  : NO
 SUSPEND TIME     N/A     14:26.7484      N/A      STOR.PRC SCHED         0.000000       0
   AGENT          N/A     14:26.7484      N/A      UDF SCHEDULE           0.000000       0
   PAR.TASKS      N/A      0.000000       N/A      DRAIN LOCK            0.000000       0
                                                   CLAIM RELEASE         0.000000       0
 NOT ACCOUNT.     N/A     23.445339       N/P      PAGE LATCH           0.709714      90
 DB2 ENT/EXIT     N/A      1040489        N/A      NOTIFY MSGS          0.000000       0
 EN/EX-STPROC     N/A         0           N/A      GLOBAL CONTENTION  9:13.014067    1191
 EN/EX-UDF        N/A         0           N/A      COMMIT PH1 WRITE I/O  0.000000       0
 DCAPT.DESCR.     N/A        N/A          N/P      ASYNCH IXL REQUESTS   0.000000       0
 LOG EXTRACT.     N/A        N/A          N/P      TOTAL CLASS 3       14:26.748354   17757
```

ACCOUNTING: IFCID003 – Sample Report (partial)

Class3 Wait: Global contention chart …

GLOBAL	CONTENTION	L-LOCKS	ELAPSED TIME	EVENTS
L-LOCKS			9:12.924287	1183
PARENT	(DB, TS, TAB, PART)		0.313377	104
CHILD	(PAGE, ROW)		9:12.610910	1079
OTHER			0.000000	0

GLOBAL	CONTENTION	P-LOCKS	ELAPSED TIME	EVENTS
P-LOCKS			0.089780	8
PAGESET/PARTITION			0.000000	0
PAGE			0.000000	0
OTHER			0.089780	8

Monitoring KEY Performance Metrics
Key Performance Metrics

1) Accounting: Threads with CLASS1_CPU > 30 minutes

```
QUERY:  (see NOTES page ...)

    SELECT   DATE, LOCAL_LOCATION, PRIMAUTH, CORRNAME
             , INSTANCE_NBR
             , CLASS1_CPU_NNESTED   AS CLASS1_CPU
             , CLASS1_CPU_NNESTED   AS CLASS2_CPU
        FROM  WIZ.DB2_ACCT_DETAIL
       WHERE  LOCAL_LOCATION  =  'DBG1'
         AND  DATE BETWEEN '2002-05-01'  and '2002-06-30'
         AND  CLASS1_CPU_NNESTED / 60  >  30
    ORDER BY 6 DESC
```

International DB2 Users Group

Query:

```
SELECT  DATE, LOCAL_LOCATION, PRIMAUTH, CORRNAME, INSTANCE_NBR
      ,  CLASS1_CPU_NNESTED  AS CLASS1_CPU
      ,  CLASS1_CPU_NNESTED  AS CLASS2_CPU
   FROM  WIZ.DB2_ACCT_DETAIL
WHERE  LOCAL_LOCATION  =  'DBG1'
     AND DATE BETWEEN '2002-05-01' and '2002-06-30'
     AND CLASS1_CPU_NNESTED / 60  >  30
ORDER BY 6 DESC
```

Monitoring KEY Performance Metrics
Key Performance Metrics

2) Accounting: Threads with CLASS3_WAIT_OTHER > 25% of Total Class3 Wait

```
QUERY:  (see NOTES page ...)
```

DB2ID	PRIMAUTH	PLAN NAME	WAIT LOCK	WAIT SYNCH/IO	WAIT OTHER	WAIT OTHER %	# OCCURS
DBA2	EPOI	PLNCC	5.64	66.12	84.36	54.04	1444
DBA1	MISCONS	FOCUS709	0.03	35.48	69.07	66.04	18
DBC2	LS2SPRP	SQLACCES	0.76	48.69	54.46	52.41	167130
DBB2	AIPI	AIFIPL16	0.07	53.54	53.09	49.75	10778
DBB2	AIPI	AIFIPLNC	0.21	41.36	43.85	51.33	9410
DBC4	C5889DR	LSI	0.01	6.47	32.89	83.55	158
DSN6	HRMSPPS	PSQED.EX	0.01	12.57	32.73	72.23	471
DSN6	HRMSPPS	PSNVS.EX	0.18	9.93	29.49	74.47	614
DSN6	HRMSPPS	PSAPISRV	3.27	1.33	26.10	85.00	77061
DSNC	PERHRM7	PSAPISRV	0.17	1.90	25.35	92.48	49322
DBC2	SAMR	SAMSMR03	0.01	0.01	6.12	99.67	25608
DBA2	MPRDO12	PLFDC	0.02	0.11	6.04	97.93	21

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CLASS3_WAIT_OTHER is all CLASS3_WAIT time except for WAIT_LOCK_LATCH and WAIT_SYNCH_IO.

Query:

Monitoring KEY Performance Metrics
Key Performance Metrics

- **Statistics:** IFCID002 (Database Statistics)
  - Trace record written at end of interval
  - Statistics traces provide information at the DB2 subsystem level…

> **SQL** (DML,DDL,DCL),
> **Subsystem Services, EDM Pool, LOG Activity,**
> **RID LIST processing,**
> **Buffer Pool, Group Buffer Pool,**
> **Locking, Data Sharing Locking,**
> **Query Parallelism, Global DDF Activity, Dynamic SQL,**
> **DBM1 Storage usage,**
> **DB2 Address Space CPU times,**
> **And much more…**

International DB2 Users Group

```
LOCATION: DBGA                      DB2 PERFORMANCE MONITOR (V7)                      PAGE: 1-1
   GROUP: SCADBGA                    STATISTICS REPORT - LONG           REQUESTED FROM: 12/23/02 00:00:00.00
  MEMBER: DBA1                                                                     TO: 12/24/02 00:00:00.00
SUBSYSTEM: DBA1                                                        INTERVAL FROM: 12/23/02 00:00:00.00
DB2 VERSION: V7                                SCOPE: MEMBER                         TO: 12/24/02 00:00:00.00

---- HIGHLIGHTS ---------------------------------------------------------------------------
INTERVAL START  : 12/23/02 00:05:29.67   SAMPLING START: 12/23/02 00:05:29.67   TOTAL THREADS       :    265.5K
INTERVAL END    : 12/23/02 23:53:39.10   SAMPLING END  : 12/23/02 23:53:39.10   TOTAL COMMITS       :   2006.2K
INTERVAL ELAPSED:    23:48:09.430755     OUTAGE ELAPSED:         0.000000        DATA SHARING MEMBER:      N/A

SQL DML              QUANTITY   /SECOND   /THREAD   /COMMIT
--------------     ----------   -------   -------   -------
SELECT               48497.3K    565.97    182.67     24.17
INSERT                3306.4K     38.59     12.45      1.65
UPDATE                4034.7K     47.09     15.20      2.01
DELETE               11775.00      0.14      0.04      0.01

PREPARE               2576.00      0.03      0.01      0.00
DESCRIBE                55.00      0.00      0.00      0.00
DESCRIBE TABLE           0.00      0.00      0.00      0.00
OPEN                 16000.3K    186.72     60.27      7.98
CLOSE                15986.2K    186.56     60.21      7.97
FETCH                79153.9K    923.73    298.14     39.45


TOTAL                 167.0M    1948.82    628.99     83.24
```
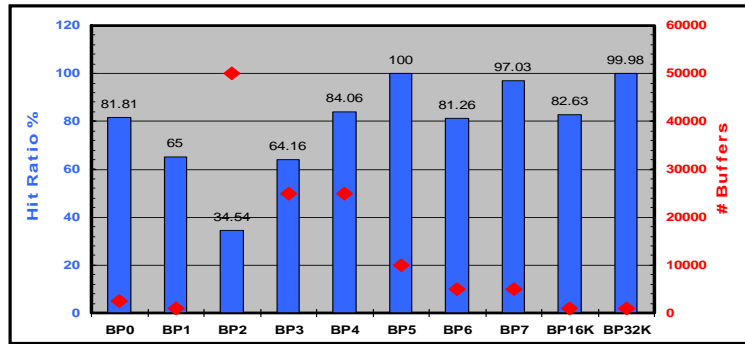
STATISTICS: IFCID001 & IFCID002 – Sample Report (partial)

Monitoring KEY Performance Metrics
Key Performance Metrics

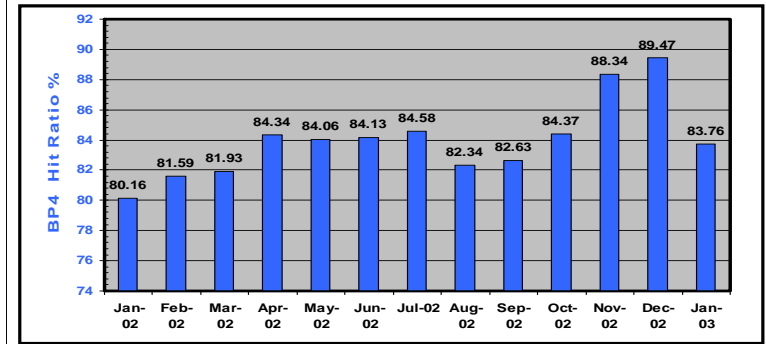1) **Statistics**: Bufferpool Metrics … [**Bufferpool Size & Hit Ratio**]

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Monitoring KEY Performance Metrics
Key Performance Metrics

2) **Statistics**: Bufferpool Metrics … [**Bufferpool Hit Ratio Trend**]

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Monitoring KEY Performance Metrics
Key Performance Metrics

3) **Statistics**:   Bufferpool Data Set metrics … **(IFCID 199) STATS CLASS(8)**

```
QUERY:   select date, interval, bp_id, syn_io_avg_delay, sync_io,
                asyn_io_avg_delay, async_io
         from wiz.db2_statdsn_intrvl
         Where local_location = 'dbga' and space_name = 'xnccacm1' and date ...

                               SYN_IO            ASYN_IO
                          BP   AVG       SYNC    AVG       ASYNC
         DATE       INTERVAL  ID  DELAY      IO     DELAY     IO
         ---------- --------  ---  ------  ---------  -------  -------
         2002-12-12 14.10.05   4     4    1006428     1      45087
         2002-12-13 14.10.21   4     3    1150367     0      51802
         2002-12-14 14.10.23   4     7      25704     2     301993
         2002-12-15 14.10.27   4     5      14026     1        407
         2002-12-16 14.10.33   4     3    1259252     0      89641
         2002-12-17 14.10.41   4     3    1107219     1      49272
         2002-12-18 14.10.49   4     4    1093357     1      52508
```

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Monitoring KEY Performance Metrics
Key Performance IFCIDs

- Dynamic SQL – IFCID 63
- Explain Information – IFCID 22
- RID Pool – IFCID 125
- Sort – IFCID 96
- And many more …

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Monitoring KEY Performance Metrics
Key Performance IFCIDs

- Dynamic SQL performance analysis is difficult … especially after the fact!
  - Which query used all the CPU?
  - We know **who** did it … but which query was it?
- Using **IFCIDs 003**, **022** and **063** we can get our answers!
  - IFCID 003 will identify the **EXPENSIVE** thread
  - IFCID 022 will provide the **EXPLAIN** data
  - IFCID 063 will identify the **SQL STATEMENT**

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Monitoring KEY Performance Metrics
Key Performance IFCIDs

- RID Pool – **IFCID 125** (Exception: RID Pool Failures)

```
LOCAL_LOCATION:  DSN2WCB   SUBSYSTEM_ID:  DSN2   DATE:  2002-07-11


                                                 RID        RID       RIDS
  LUW                                      RID  NOT_USED  NOT_USED  IN_FINAL
INSTANCE      PRIMAUTH  TIMESTAMP          USAGE  "STOR"    "MAX"     LIST
------------  --------  -------------------------  -----  --------  --------  --------
B7E96D889551  JBORGES   2002-07-11-17.18.26.287192   N      Y                    -2
B7E9A0BB32E7  KULKER    2002-07-11-21.09.00.645262   N               Y           -2


  LUW         PLAN      PROG                              INDEX               INDEX
INSANCE       NAME      NAME      STATEMENT  DBID  OBID    RIDS            THRESHOLD
------------  --------  --------  ---------  -----  ----  ---------------  ---------
B7E96D889551  QMFPLAN   DSQCFSQL       2771   471   6   -2 (NO STORAGE)       327680
B7E9A0BB32E7  ACT711DM  ACTBQT          628   632   6   -3 (MAX LIMIT)        65536
```

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Monitoring KEY Performance Metrics
Key Performance IFCIDs

- Sort – **IFCID 96** (Sort End Statistics)

```
LOCAL_LOCATION:  DSN2WCB   SUBSYSTEM_ID:  DSN2   PRIMAUTH:  KULKER

PLAN_NAME:  J458YPLN   PROGRAM_NAME:  J458Y244   LUW_INSTANCE:  B7EA2546F9ED


  STMT                               RETURN    RECORDS     SORT_DATA    SORT_KEY
  NO    TIMESTAMP                     CODE      SORTED       AREA         SIZE
  ----  --------------------------   ------   -----------   ----------   ----------
  117   2002-07-12-13.32.01.517807      0      1207630         20          19
  117   2002-07-12-13.55.46.044012      0      1030156         20          19
  117   2002-07-12-14.02.57.666741      0       813664         20          19


  SORT_RECORD      WORK         INIT_WORK    MERGE    SORT
    SIZE          FILES          FILES       PASSES   TYPE
  -----------   -----------   -----------   ------   -----
         39            29            28        1     ESA
         39            28            27        1     ESA
         39            20            19        1     ESA
```

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Monitoring KEY Performance Metrics
Key Performance IFCIDs

- And <u>many</u> more …
  - Data sharing
    - IFCID 230 – Group Buffer Pool Attributes
    - IFCID 254 – Coupling Facility Cache Structure Statistics
    - IFCID 261 – Group Buffer Pool Checkpoint
    - IFCID 262 – GBPOOLT Castout Threshold Processing
    - IFCID 263 – PAGE Set and Partition Castout Detail
  - Parallelism
    - IFCID 221 – Parallel Group Execution
    - IFCID 222 – Parallel Group Elapsed Time
    - IFCID 231 – Parallel Group Task Time

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Monitoring KEY Performance Metrics
Key Performance IFCIDs

- And <u>many</u> more …
  - Locking
    - IFCID 172 – Deadlock Data
    - IFCID 196 – Timeout Data
    - "Various" Lock Suspend/Resume – IFCID 44-45, 213-216, 226-227
  - Scan End
    - IFCID 18 – Scan End
  - End SQL
    - IFCID 58 – End SQL
  - Long Running Units of Work
    - IFCID 313 – Uncommitted Unit of Recovery
  - Etc …

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Monitoring KEY Performance Metrics
Key Performance IFCIDs

There are 220+ IFCIDs …
and growing with every release!
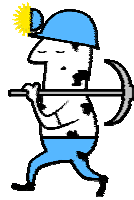A wealth of information
Ready to be mined!

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Summary …

NO
DB2 Performance Monitoring
Is complete
Without a
DB2 Performance Database.
Start Mining Your
DB2 PDB!

How to Build Your Own DB2 Performance Database
Session: A6

Thank-You!

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