DB2 UDB V8
Autonomic Computing

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Why Autonomic Computing?

- Complexity: it ain't getting any easier!!
  - more and more DBs, tables, users: 100s => 1,000s => 10,000s
  - large applications, GBs & TBs of data, clusters of servers
  - need to keep 1000s of users connected to 100s of DBs

- Who's gonna set it up and keep it running?
  - skilled DBAs are increasingly rare
  - ISVs, .COMs want embedded, invisible DBs
  - smaller shops don't have specialized skills, must diversify
What's the Cost of Running a Database?

Server TCO: Internal Maintenance Costs 28.0%

Implementation 37.0%

Training Costs 16.0%

Upgrades 4.0%

Database License 8.0%

Developer Tools 4.0%

Client Access 3.0%

Study of a competitive DBMS product, NOT DB2

Source: The AberdeenGroup, 1998
http://relay.bvk.co.yu/progress/aberdeen/aberdeen.htm
Autonomic Computing -- Now that's SMART!!

The DB2 system self-monitors & self-regulates

A "Sympathetic" DB2
- monitors itself looking for sub-optimal performance, design, etc.
- looks out for sub-systems that require routine maintenance
- seeks out resource inadequacies

And a "Calming" DB2
- provides expert advice on improving performance, capacity planning, appropriate windows of opportunity to do maintenance
- automatically balances resource usage, compensates for outages, adjusts "designs" based on workload, and so on ...

Data Management Software
A SMART DB2: What's our Focus?

- Self Managing And Resource Tuning (SMART) Databases
  - Technology for reducing human intervention/cost in the operation of a DBMS that includes one or more of the qualities of automation, decision making, or expert advice.
  - Part of IBM's larger eLiza effort for self managing servers.

Focus areas:
- Up and running
- Expert design
- Self-maintaining
- Self-healing
- Auto-recovering
A SMART DB2: What's our Focus?

- **Up and Running**
  - pre-purchase capacity planning tools
  - automate install and initial configuration
- **Design**
  - advise on logical and physical design
- **Maintenance**
  - automatic tuning for queries, resources
  - physical maintenance (runstats, reorg ...)
- **Problem Determination and Resolution**
  - detecting existing, and predicting future
  - user notification
  - self-correcting features
- **Availability and Disaster Recovery**
  - availability
  - backup and log management
A SMART DB2: What's our Focus?

Lots of stuff to do ... what shall we get started on?

Across the Industry, and DBMSes ...
DB2 UDB Version 8.1 Features

- Health Center
- Configuration Advisor Enhancements
- Buffer Pool Analyzer
- Recovery Expert
- Performance Expert: Applications
- Automatically Tuned Configuration Parameters
- Automatic Deadlock Identification
The Steps to Automonic Computing

- It's important to understand we're on an evolutionary path.

- We need to crawl before we walk, and walk before we run.

- We need to gain your trust, and give you control when necessary.
Health Monitoring

► Why?
  - how do you know if DB2 is running okay, performing well?
  - what do you do if you do manage to figure out it's "unhealthy?"
  - too difficult to determine what to monitor and when to monitor it
  - need to set up monitors, notification & resolution mechanisms

► Management-by-exception model:
  - DB2 monitors its own health right out of the box
  - notifies upon encountering unhealthy conditions
  - advises on severity of condition, and suggests resolutions
  - initiates corrective action if required and requested

► An Up-and-Running Dream!!
  - install DB2, provide an e-mail or pager address, "db2start"
What are the health indicators?

- Application concurrency
  - Deadlock rate, lock list utilization
- Database Manager and Database
  - Operational state
- Logging
  - Log utilization, log filesystem utilization
- Memory
  - Database heap utilization, query heap utilization
- Package and catalog caches
  - Package cache hit ratio
- Sorting
  - Percentage of sorts that overflowed, shared sort memory utilization
- Tablespace storage
  - Table space utilization, operational state
Health Monitoring: Automating PD&R

- automatically, cheaply monitor health w/o setup/configuration
- allow for automatic resolution of unhealthiness
- **Caveat**: not all resolutions can be automated!
  - require manual intervention (hard limit like disk full)
  - too complicated (many interrelations, interactions)
  - too risky

Feedback Loop

- Health & Welfare
  - what to monitor?
  - how to achieve low overhead monitoring?
  - how do I know there's a problem?

- Problem Determination & Resolution
  - how and why did this happen?
  - what are the implications of encountering this problem?
  - does this affect anything else or is it isolated?
  - how do I fix it, and what is the "best" fix
  - when do I fix it?

Automatic vs. Manual or Automatic
Data Management Software

Health Center

Node type = Database Server with local clients
Instance name = horman
Snapshot timestamp = 03-27-2002 13:24:51.799180

Database Manager Health Indicators:

Health Indicator ID = 2 (db2.sort_privmem_util)
Value = 86
Alert state = warning

Choose Instance > Current Alerts

<table>
<thead>
<tr>
<th>Alert Type</th>
<th>Health Indicator</th>
<th>Value</th>
<th>Category</th>
<th>Object Name</th>
<th>Partition</th>
<th>Object Type</th>
<th>Time Stamp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarms</td>
<td>Database wide shared sort memory utilisation</td>
<td>89%</td>
<td>Memory</td>
<td>Matrix.Artisan</td>
<td>0</td>
<td>Database</td>
<td>7/17/2001 08:00</td>
</tr>
<tr>
<td>Alarms</td>
<td>Container One is running out of space</td>
<td>96%</td>
<td>File</td>
<td>Matrix.Artisan</td>
<td>0</td>
<td>Database</td>
<td>7/17/2001 08:00</td>
</tr>
<tr>
<td>Warning</td>
<td>Container Three is running out of space</td>
<td>92%</td>
<td>File</td>
<td>Matrix.Artisan</td>
<td>0</td>
<td>Database</td>
<td>7/17/2001 08:00</td>
</tr>
</tbody>
</table>

(horman@healthy) /home/horman $ db2 get health snapshot for DBM

Database Manager Health Snapshot

Node type = Database Server with local clients
Instance name = horman
Snapshot timestamp = 03-27-2002 13:24:51.799180

Database Manager Health Indicators:

Health Indicator ID = 2 (db2.sort_privmem_util)
Value = 86
Alert state = warning
If you need to do some digging/investigation before choosing an appropriate action, Health Center launches tools in context.

**e.g.**

need to consider "competitors" of a constrained resource.

**NOTE:** for many corrective actions, DB/DBM cfg parms can be dynamically updated!!!
Configuration Advisor Enhancements

- More sophisticated model, better decisions for OLTP and DSS
  - Remarkable benchmark results (well-known, industry-standard OLTP workload)
- New CLP command: AUTOCONFIGURE
  ```
  AUTOCONFIGURE [USING config-keyword value [{,config-keyword value}...]]
  [APPLY {DB ONLY | DB AND DBM | NONE}]
  ```

  config-keyword:
  `MEM_PERCENT, WORKLOAD_TYPE, NUM_STMTS, TPM, ADMIN_PRIORITY, IS_POPULATED,
  NUM_LOCAL_APPS, NUM_REMOTE_APPS, ISOLATION, BP_RESIZEABLE`.

- New CLP command extension for CREATE DATABASE
  ```
  CREATE DATABASE database-name
  [AT DBPARTITIONNUM | [ON path] [ALIAS database-alias]
  ...
  [AUTOCONFIGURE [USING config-keyword value [{,config-keyword value}...]]
  [APPLY {DB ONLY | DB AND DBM | NONE}]]
  ```

  config-keyword:
  `MEM_PERCENT, WORKLOAD_TYPE, NUM_STMTS, TPM, ADMIN_PRIORITY,
  NUM_LOCAL_APPS, NUM_REMOTE_APPS, ISOLATION, BP_RESIZEABLE`. 
Configuration Advisor Enhancements

Look at us now!!!

- **91.3%** for Workload 1
- **98.4%** for Workload 2

For a specific OLTP benchmark

**Data Management Software**

**Workload 1 Workload 2**

- Default
- Wizard
- Expert

Transactions Per Minute

- 2023
- 3297
- 8136
- 8268

- 8403
- 9206
- 9860
- 9860

2023  8268  98.4%
2023  9860  98.4%
91.3%
2023  8268  98.4%
2023  9860  98.4%
91.3%
2023  8268  98.4%
2023  9860  98.4%
91.3%
Configuration Advisor

Select the type of workload that best reflects your database.

You can optimize your database for a particular type of workload. If your database is mostly used for queries, select Queries. If it is mostly used for transactions, select Transactions. If you are not sure, or if it is mixed, select Mixed.

Optimize for workload type:
- Queries (data warehousing)
- Mixed
- Transactions (order entry)
Data Management Software

- Makes it easy to tune your buffer pools
- Provides expert knowledge and recommendations
- Recommends BP size & threshold changes
- Collects summary and detail buffer pool data
- Simulates buffer pool performance to help anticipate the impact of changes
- Allows iterative buffer pool simulation
- Generates a variety of reports, displays results in multiple formats, including:

Remember: many DB / DBM configuration parms can be dynamically updated!!!
Recovery Expert

- Determines the type of recovery process to use when recovery is requested.
- Performs log analysis to back out transactions, or choose to do log-forward recovery from a backup image.

OOPS!

now where did that table go?
Performance Expert: Applications

- Application reports generated by Performance Expert for Multiplatform
- Identifies specific application performance issues
- Gives prioritized tuning recommendations within reports
- Exception reports for 9 common performance problems
  - e.g. identify and quantify excessive CPU and elapsed time on a plan and package basis
- Collects workload with minimum overhead
Automatically-Tuned Configuration Parameters

- You can set some DBM and DB configuration parameters to AUTOMATIC, and let DB2 do the work for you.
- **DBM example:**

  ```
  Database Manager Configuration
  
  Node type = Database Server with local clients
  
  Database manager configuration release level = 0x0a00
  
  . . .
  
  Size of instance shared memory (4KB) (INSTANCE_MEMORY) = AUTOMATIC
  
  . . .
  ```

- **DB example:**

  ```
  Database Configuration for Database Auto
  
  Description Parameter Current Value Delayed Value
  
  Database configuration release level = 0x0a00
  Database release level = 0x0a00
  
  Size of database shared memory (4KB) (DATABASE_MEMORY) = AUTOMATIC (8416) AUTOMATIC (8416)
  Catalog cache size (4KB) (CATALOGCACHE_SZ) = (MAXAPPLS*4) (MAXAPPLS*4)
  Package cache size (4KB) (PCKCACHESZ) = (MAXAPPLS*8) (MAXAPPLS*8)
  Max number of active applications (MAXAPPLS) = AUTOMATIC (40) AUTOMATIC (40)
  ```
Automatic Deadlock Identification

- convenient to have deadlock info captured automatically
- avoids hassle of setting up deadlock event monitoring for every DB, and ensuring it's active when you actually need it
- improved deadlock information simplifies analysis greatly:

5) Deadlocked Connection ...

Deadlock Id: 6
Deadlock Node: 10
Participant no.: 1
Participant no. holding the lock: 2
Deadlock detection time: 08-22-2000 16:45:56.251972
Table of lock waited on : STAFF
Schema of lock waited on : RIIHI
Tablespace of lock waited on : USERSPACE1
Type of lock: Row
Mode of lock: X
Mode application requested on lock: NS
Node lock occurred on: 0
Lock object name: 39
Application Handle: 6
Deadlocked Statement:
  Type : Dynamic
  Operation: Close
  Section : 201
  Creator : NULLID
  Package : SQLC2D01
  Cursor : SQLCUR201
  Cursor was blocking: FALSE
  Text : select name from staff

List Of Locks:

- Lock Object Name = 3
  Node number lock is held at = 0
  Object Type = Table
  Tablespace Name = USERSPACE1
  Table Schema = RIIHI
  Table Name = STAFF
  Mode = IS
  Status = Granted
  Lock Escalation = NO

- Lock Object Name = 13
  Node number lock is held at = 0
  Object Type = Row
  Tablespace Name = USERSPACE1
  Table Schema = RIIHI
  Table Name = DEPARTMENT
  Mode = X
  Status = Granted
  Lock Escalation = NO

- Lock Object Name = 4
  Node number lock is held at = 0
  Object Type = Table
  Tablespace Name = USERSPACE1
  Table Schema = RIIHI
  Table Name = DEPARTMENT
  Mode = IX
  Status = Granted
  Lock Escalation = NO
Future Enhancements

- Activity Monitor
- MQT Advisor
- Data Partitioning Advisor
- Maintenance Advisor
- LEO (Self-tuning optimizer)
- Meta-optimizer
- Self-Throttling Utilities
- More auto-cfg parms
Activity Monitor

- Greatly simplifies application problem determination and resolution
  - provides many "canned" reports on application activity
  - for each report, provides detailed description of why report is useful, and recommendations for fixing problems identified
  - links in tools that can be used to drill down or fix problems

- Two modes of operation:
  - live: facilitates real-time investigation
  - recording: unattended mode, efficiently stored data in tables

- Three modes of interaction:
  - APIs: stored procedures and table UDFs
  - CLP: use CALL SQL statement to invoke store procs and UDFs
  - GUI: Java tools invoked from cmd-line or within CC toolset
Design Advisor

Extension to DB2 Index Advisor to support Materialized Query Tables (MQTs)
- input is the same -- workload, system, DB info
- constraints are the same -- disk space, time limit
- can select MQTs, indexes, or both
- INSERTs/UPDATEs/DELETEs add penalties for creating too many indexes or MQTs
- user can modify recommendations

New features, just for MQTs
- finds common subpieces between multiple queries
- statistics for candidate MQTs from
  - optimizer's estimates (default)
  - sample of MQT's data (optional)
- interaction of MQTs and indexes
Data Partitioning Advisor

Scope
- DB2 Enterprise Server Edition (ESE)
- Shared-nothing parallelism
- Data stored horizontally partitioned
  - in a partitiongroup, spread across specified partitions
  - based upon hashing of partitioning column(s)
  - may be replicated across all partitions of a partitiongroup
- Need to collocate similar values for joins, aggregation
- Partitioning required for a given table may be different ..
  - between queries
  - even within a query (joined on different columns)

Problem: What is optimal partitioning for each table, given:
- Workload of queries
- Schema, including set of partitiongroups and tablespaces
- Statistics on database
Maintenance Advisor

- Recommendations on regular maintenance
  - data defragmentation, clustering
  - statistics collection
  - backups
- Sensitive to current workload, batch windows
- Self-deprecating when other important work needs to run
- Cross-platform: Linux, UNIX, Windows, z/OS

What?       How?       When?

Execute
Wrap It Up!

- Reduce complexity, simplify life ... an autonomic DB2!
- We're making inroads - look what's in V8
- We have many SMART projects in the hopper, some of which are coming your way soon
- We mean business. This is important to us.
- And remember to always ...

Live, Breathe, and Eat SMART