Db2 Basics: Autonomic Features

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Agenda

- Review of Autonomic Features
- Controlling Db2 Autonomic Features
- STMM
- Monitoring
- Questions

au·to·nom·ic [ô′ tə-nŏm′ ĭk]

- *adj.* Resulting from internal stimuli; spontaneous.

Autonomics in a Database

- 4 keys to an autonomic system
  - Automatic
  - Adaptive
  - Aware
  - Self-Managing

Autonomics: Replacing the DBA?

No!

Autonomics: Replacing the DBA?

- DBAs have larger, more complex systems to manage
- Autonomic features allow DBAs to focus on high-value activities

Autonomic Features in Db2

- 5 Key Areas:
  - Automatic Configuration
  - Automatic Storage
  - Automatic Maintenance
  - Automatic Compression Dictionary creation
  - Self-Tuning Memory Manager (STMM)

Automatic Configuration

- Adjusts configuration based on user-supplied inputs
  - Percentage of Server Memory to Use
  - Workload Characteristics
  - Recoverability
- Scope:
  - Registry Variables
  - Database Manager Configuration
  - Database Configuration
  - WLM Configuration
  - Bufferpools

Previewing Configuration Changes

```
db2 "AUTOCONFIGURE USING
     MEM_PERCENT 80
     TPM 12000
     NUM_REMOTE_APPS 1200
     ISOLATION CS
     APPLY NONE"
```

Current and Recommended Values for Database Manager Configuration

Description	Parameter	Current Value	Recommended Value
Application support layer heap size (4KB)	(ASLHEAPSZ)	15	15
Number of FCM buffers	(FCM_NUM_BUFFERS)	AUTOMATIC(4096)	AUTOMATIC(22731)
Enable intra-partition parallelism	(INTRA_PARALLEL)	NO	NO
Maximum query degree of parallelism	(MAX_QUERYDEGREE)	ANY	4
Agent pool size	(NUM_POOLAGENTS)	0	AUTOMATIC (100)
Initial number of agents in pool	(NUM_INITAGENTS)	0	0
Max requester I/O block size (bytes)	(RQRIOBLK)	65535	65535
Sort heap threshold (4KB)	(SHEAPTHRES)	0	0
Global instance memory (% or 4KB)	(INSTANCE_MEMORY)	AUTOMATIC (2597815)	AUTOMATIC (2597815)
FCM buffer size	(FCM_BUFFER_SIZE)	32768	32768
FCM parallelism	(FCM_PARALLELISM)	AUTOMATIC(6)	AUTOMATIC(6)

Current and Recommended Values for System WLM Objects

Description	Current Value	Recommended Value
Work Action SYSMAPMANAGEDQUERIES Enabled	= Y	Y
Work Action Set SYSDEFAULTUSERWAS Enabled	= Y	Y

Implementing Configuration Changes

```
db2 "AUTOCONFIGURE USING
     MEM_PERCENT 80
     TPM 12000
     NUM_REMOTE_APPS 400
     ISOLATION CS
     APPLY DB AND DBM"

db2stop
db2start
```

Automatic Storage

- Db2 automatically assigns physical containers for storage
  - Underlying storage type (DMS vs SMS)
  - Growth is handled without user intervention

- Db2 determines optimal prefetch sizes
  - Changes occur when storage paths are added or at database start

Using Automatic Storage

- Creating a database:

```
db2 "create database on /path1, /path2, /path3"
```

- Creating Storage Group

```
db2 "create stogroup SG_SSD on '/path4', ‘/path5'"
```

- Adding Storage

```
db2 "alter database add storage on /path6"
db2 "alter stogroup SG_SSD add '/path7'"
```

Viewing Automatic Storage Configuration

```
$ db2pd -db SAMPLE -storage

Database Member 0 -- Database SAMPLE -- Active -- Up 2 days 19:52:52 -- Date
2022-05-21-23.57.06.110060

Storage Group Configuration:
Address            SGID  Default  DataTag    Name
0x00007FA763D42820 0     Yes      0          IBMSTOGROUP

Storage Group Statistics:
Address            SGID  State      Numpaths  NumDropPen
0x00007FA763D42820 0     0x00000000 3         0

Storage Group Paths:
Address            SGID  PathID    PathState    PathName
0x00007FA763D66000 0     0         InUse        /database/data1
0x00007FA763D68000 0     1         InUse        /database/data2
0x00007FA763D6A000 0     1         InUse        /database/data3
```

Automatic Maintenance

```
$ db2 get db cfg for SAMPLE

 ...

 Automatic maintenance                       (AUTO_MAINT) = ON
   Automatic database backup               (AUTO_DB_BACKUP) = OFF
   Automatic table maintenance             (AUTO_TBL_MAINT) = ON
     Automatic runstats                     (AUTO_RUNSTATS) = ON
       Real-time statistics                (AUTO_STMT_STATS) = ON
       Statistical views                  (AUTO_STATS_VIEWS) = OFF
       Automatic sampling                    (AUTO_SAMPLING) = OFF
       Automatic column group statistics (AUTO_CG_STATS) = OFF
     Automatic reorganization                   (AUTO_REORG) = OFF

 ...
```

Automatic Maintenance

```
$ db2 get db cfg for SAMPLE

 ...

 Automatic maintenance                       (AUTO_MAINT) = ON
   Automatic database backup                 (AUTO_DB_BACKUP) = OFF
   Automatic table maintenance               (AUTO_TBL_MAINT) = ON
     Automatic runstats                       (AUTO_RUNSTATS) = ON
       Real-time statistics                  (AUTO_STMT_STATS) = ON
       Statistical views                    (AUTO_STATS_VIEWS) = OFF
       Automatic sampling                     (AUTO_SAMPLING) = OFF
       Automatic column group statistics (AUTO_CG_STATS) = OFF
     Automatic reorganization                    (AUTO_REORG) = OFF

 ...
```

Database must be activated for automatic maintenance to occur

Automatic Maintenance Policies

- Db2 uses policies to control automatic maintenance
- 4 Types:
  - MAINTENANCE_WINDOW
  - AUTO_BACKUP
  - AUTO_REORG
  - AUTO_RUNSTATS

Viewing Current Policies

- Use AUTOMAINT_GET_POLICYFILE procedure
  - Writes XML file containing requested policy
    - Writes to …/sqllib/tmp on Linux
    - Writes to %DB2INSTPROF%\tmp on Windows
      - Typically: C:\ProgramData\IBM\DB2\DB2COPY1\DB2\TMP

```
$ db2 "call automaint_get_policyfile('MAINTENANCE_WINDOW','maint_window.xml')"

  Return Status = 0
```

Default MAINTENANCE_WINDOW Policy

```
$ cat $HOME/sqllib/tmp/maint_window.xml

<?xml version="1.0" encoding="UTF-8"?>
<DB2MaintenanceWindows
xmlns="http://www.ibm.com/xmlns/prod/db2/autonomic/config" >

 <!-- Online Maintenance Window  -->
 <OnlineWindow Occurrence="During" startTime="00:00:00" duration="24" >
  <DaysOfWeek>All</DaysOfWeek>
  <DaysOfMonth>All</DaysOfMonth>
  <MonthsOfYear>All</MonthsOfYear>
 </OnlineWindow>
</DB2MaintenanceWindows>
```

Modified MAINTENANCE_WINDOW Policy

```
$ cat $HOME/sqllib/tmp/maint_window.xml

<?xml version="1.0" encoding="UTF-8"?>
<DB2MaintenanceWindows
xmlns="http://www.ibm.com/xmlns/prod/db2/autonomic/config" >

 <!-- Online Maintenance Window  -->
 <OnlineWindow Occurrence="During" startTime="02:00:00" duration="2" >
  <DaysOfWeek>Sat Sun</DaysOfWeek>
  <DaysOfMonth>All</DaysOfMonth>
  <MonthsOfYear>All</MonthsOfYear>
 </OnlineWindow>
</DB2MaintenanceWindows>
```

Updating an Automatic Maintenance Policy

- Use AUTOMAINT_SET_POLICYFILE procedure
  - Reads XML file containing requested and updates configuration
    - Reads from …/sqllib/tmp on Linux
    - Reads from %DB2INSTPROF%\tmp on Windows
      - Typically: C:\ProgramData\IBM\DB2\DB2COPY1\DB2\TMP

```
$ db2 "call automaint_set_policyfile('MAINTENANCE_WINDOW','maint_window.xml')"

  Return Status = 0
```

Automatic Database Backups

```
$ db2 get db cfg for SAMPLE

 ...

 Automatic maintenance                       (AUTO_MAINT) = ON
   Automatic database backup                (AUTO_DB_BACKUP) = OFF
   Automatic table maintenance              (AUTO_TBL_MAINT) = ON
     Automatic runstats                      (AUTO_RUNSTATS) = ON
       Real-time statistics                 (AUTO_STMT_STATS) = ON
       Statistical views                   (AUTO_STATS_VIEWS) = OFF
       Automatic sampling                    (AUTO_SAMPLING) = OFF
       Automatic column group statistics (AUTO_CG_STATS) = OFF
     Automatic reorganization                   (AUTO_REORG) = OFF

 ...
```

Automatic Database Backups

- Db2 will automatically back up the database based on:
  - The time elapsed since the last full backup
  - The transaction log space consumed since the last backup
- Backups written to Disk, TSM, Vendor DLL
- Controlled by AUTO_BACKUP policy

AUTO_BACKUP Policy

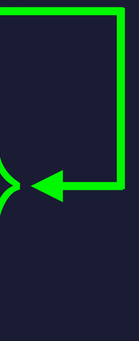
```
$ cat $HOME/sqllib/tmp/autobackup.xml

<?xml version="1.0" encoding="UTF-8"?>
<DB2AutoBackupPolicy
xmlns="http://www.ibm.com/xmlns/prod/db2/autonomic/config" >

 <!--   Backup Options  -->
 <BackupOptions mode="Online">
  <BackupTarget>
  <DiskBackupTarget>
    <PathName>/backup/db2inst1/full</PathName>
  </DiskBackupTarget>
  </BackupTarget>
 </BackupOptions>

 <!--  Frequency of automatic backups -->

 <BackupCriteria numberOfFullBackups="1" timeSinceLastBackup="168"
logSpaceConsumedSinceLastBackup="6400"/>
```

AUTO_BACKUP Limitations

- Backup policy evaluated every 2 hours
- Just 2 backup images are retained on disk
  - AUTO_BACKUP policy does not follow NUM_DB_BACKUPS
- No backup options can be specified
  - Uncompressed backups

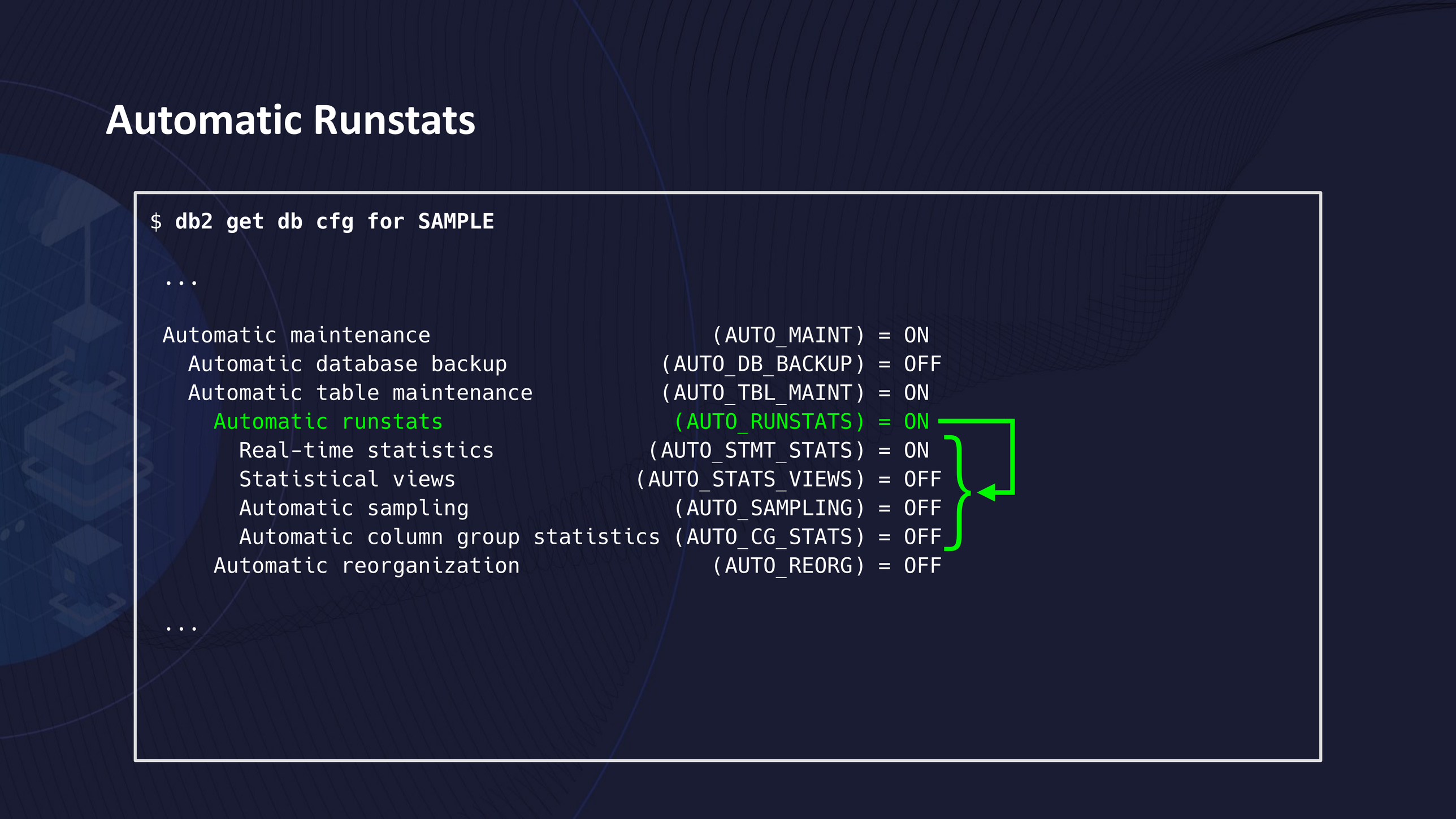
Automatic Table Maintenance

```
$ db2 get db cfg for SAMPLE

 ...

 Automatic maintenance                       (AUTO_MAINT) = ON
   Automatic database backup                 (AUTO_DB_BACKUP) = OFF
   Automatic table maintenance               (AUTO_TBL_MAINT) = ON
     Automatic runstats                       (AUTO_RUNSTATS) = ON
       Real-time statistics                  (AUTO_STMT_STATS) = ON
       Statistical views                    (AUTO_STATS_VIEWS) = OFF
       Automatic sampling                     (AUTO_SAMPLING) = OFF
       Automatic column group statistics (AUTO_CG_STATS) = OFF
     Automatic reorganization                    (AUTO_REORG) = OFF

 ...
```



Automatic Runstats

```
$ db2 get db cfg for SAMPLE

 ...

 Automatic maintenance                       (AUTO_MAINT) = ON
   Automatic database backup               (AUTO_DB_BACKUP) = OFF
   Automatic table maintenance             (AUTO_TBL_MAINT) = ON
     Automatic runstats                     (AUTO_RUNSTATS) = ON
       Real-time statistics                (AUTO_STMT_STATS) = ON
       Statistical views                  (AUTO_STATS_VIEWS) = OFF
       Automatic sampling                    (AUTO_SAMPLING) = OFF
       Automatic column group statistics (AUTO_CG_STATS) = OFF
     Automatic reorganization                   (AUTO_REORG) = OFF

 ...
```



Automatic Runstats

- AUTO_RUNSTATS enables RUNSTATS to execute asynchronously
- Triggered by
  - Number of updates/inserts/deletes occur on a table
  - No statistics exist
- Evaluated every 2 hours
- Runs only in Online Maintenance Window
- RUNSTATS is run in throttled mode
- Can control options using statistical profile

AUTO_RUNSTATS Policy

```
$ cat $HOME/sqllib/tmp/autorunstats.xml

<?xml version="1.0" encoding="UTF-8"?>

<DB2AutoRunstatsPolicy
xmlns="http://www.ibm.com/xmlns/prod/db2/autonomic/config" >
 <RunstatsTableScope>
  <FilterCondition>TABSCHEMA NOT LIKE 'EMP%' </FilterCondition>
 </RunstatsTableScope>
</DB2AutoRunstatsPolicy>
```

Automatic Runstats - Real-time statistics

```
$ db2 get db cfg for SAMPLE

 ...

 Automatic maintenance                       (AUTO_MAINT) = ON
   Automatic database backup                 (AUTO_DB_BACKUP) = OFF
   Automatic table maintenance               (AUTO_TBL_MAINT) = ON
     Automatic runstats                       (AUTO_RUNSTATS) = ON
       Real-time statistics                  (AUTO_STMT_STATS) = ON
       Statistical views                    (AUTO_STATS_VIEWS) = OFF
       Automatic sampling                     (AUTO_SAMPLING) = OFF
       Automatic column group statistics (AUTO_CG_STATS) = OFF
     Automatic reorganization                    (AUTO_REORG) = OFF

 ...
```

Automatic Real-Time Statistics

- “Synchronous” collection - occurs when a statement is compiled
  - Collection time limited to 5 seconds
- Triggered by volume of U/I/D operations on a table
- Works with declared temporary tables
- Fabricated statistics are cached in catalog cache
  - Watch for catalog cache overflows

Automatic Runstats - Statistical Views

```
$ db2 get db cfg for SAMPLE

 ...

 Automatic maintenance                       (AUTO_MAINT) = ON
   Automatic database backup                 (AUTO_DB_BACKUP) = OFF
   Automatic table maintenance               (AUTO_TBL_MAINT) = ON
     Automatic runstats                       (AUTO_RUNSTATS) = ON
       Real-time statistics                  (AUTO_STMT_STATS) = ON
       Statistical views                    (AUTO_STATS_VIEWS) = OFF
       Automatic sampling                     (AUTO_SAMPLING) = OFF
       Automatic column group statistics (AUTO_CG_STATS) = OFF
     Automatic reorganization                    (AUTO_REORG) = OFF

 ...
```

Automatic Runstats - Sampling

```
$ db2 get db cfg for SAMPLE

 ...

 Automatic maintenance                       (AUTO_MAINT) = ON
   Automatic database backup               (AUTO_DB_BACKUP) = OFF
   Automatic table maintenance             (AUTO_TBL_MAINT) = ON
     Automatic runstats                     (AUTO_RUNSTATS) = ON
       Real-time statistics                (AUTO_STMT_STATS) = ON
       Statistical views                  (AUTO_STATS_VIEWS) = OFF
       Automatic sampling                    (AUTO_SAMPLING) = OFF
       Automatic column group statistics (AUTO_CG_STATS) = OFF
     Automatic reorganization                   (AUTO_REORG) = OFF

 ...
```

Automatic Runstats - Column Group Statistics

```
$ db2 get db cfg for SAMPLE

 ...

 Automatic maintenance                       (AUTO_MAINT) = ON
   Automatic database backup               (AUTO_DB_BACKUP) = OFF
   Automatic table maintenance             (AUTO_TBL_MAINT) = ON
     Automatic runstats                     (AUTO_RUNSTATS) = ON
       Real-time statistics                (AUTO_STMT_STATS) = ON
       Statistical views                  (AUTO_STATS_VIEWS) = OFF
       Automatic sampling                    (AUTO_SAMPLING) = OFF
       Automatic column group statistics (AUTO_CG_STATS) = OFF
     Automatic reorganization                   (AUTO_REORG) = OFF

 ...
```

Automatic Table Reorganization

```
$ db2 get db cfg for SAMPLE

 ...

 Automatic maintenance                       (AUTO_MAINT) = ON
   Automatic database backup                 (AUTO_DB_BACKUP) = OFF
   Automatic table maintenance               (AUTO_TBL_MAINT) = ON
     Automatic runstats                       (AUTO_RUNSTATS) = ON
       Real-time statistics                  (AUTO_STMT_STATS) = ON
       Statistical views                    (AUTO_STATS_VIEWS) = OFF
       Automatic sampling                     (AUTO_SAMPLING) = OFF
       Automatic column group statistics (AUTO_CG_STATS) = OFF
     Automatic reorganization                    (AUTO_REORG) = OFF

 ...
```

Automatic Reorg

- Performs REORGs on tables that violate REORGCHK formulas
- Performs classic (offline) reorgs of tables
  - Requires offline maintenance window
  - Can limit size of tables
- Index reorgs can be online (“allow write access”)
  - Additional options available for volatile tables

AUTO_REORG Policy

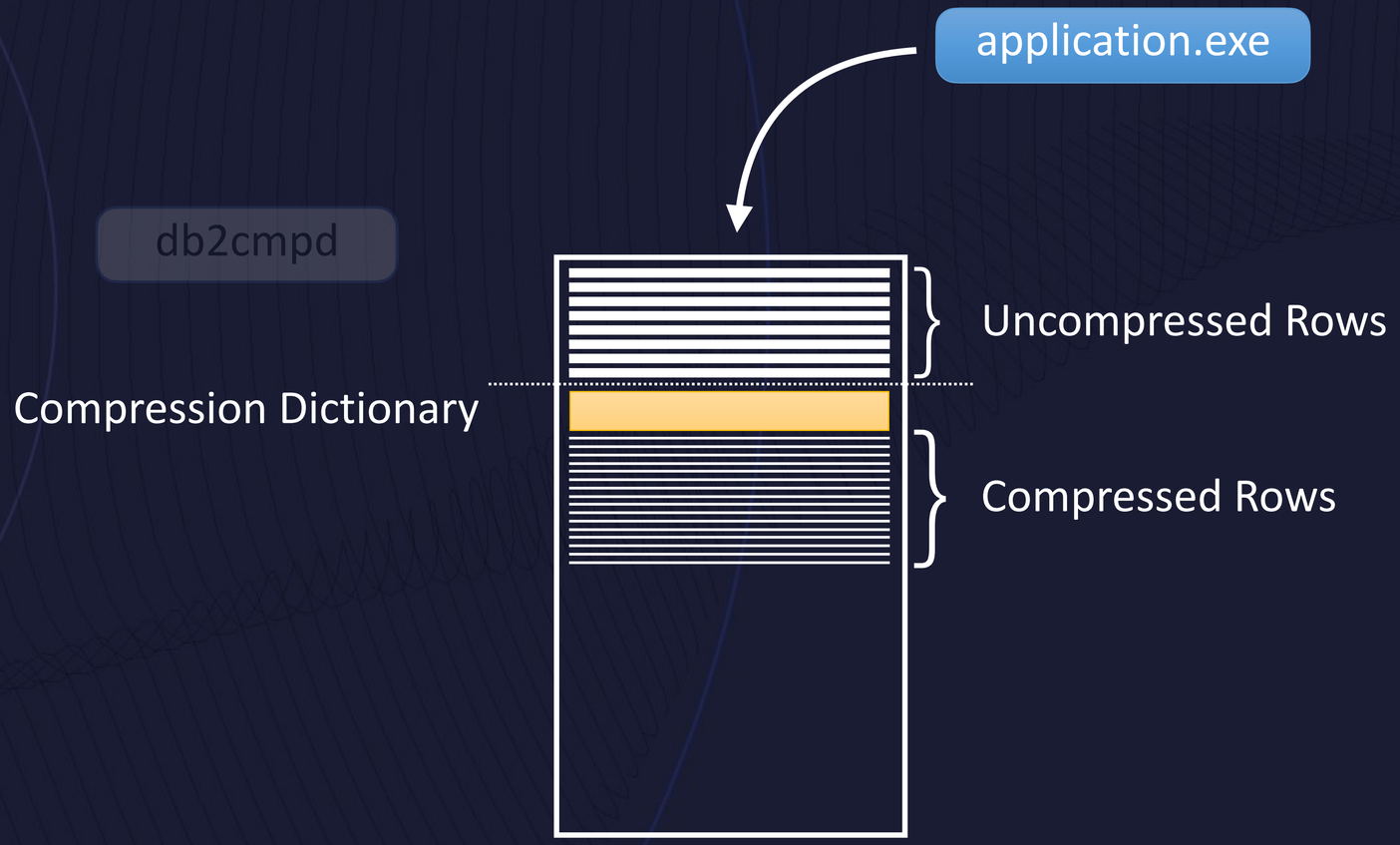
```
$ cat $HOME/sqllib/tmp/autorunstats.xml

<?xml version="1.0" encoding="UTF-8"?>
<DB2AutoReorgPolicy
xmlns="http://www.ibm.com/xmlns/prod/db2/autonomic/config" >

 <ReorgOptions dictionaryOption="Keep" indexReorgMode="Offline"
useSystemTempTableSpace="true" />

 <ReorgTableScope  maxOfflineReorgTableSize=“1024">
  <FilterClause>TABSCHEMA NOT LIKE 'SYS%'</FilterClause>
 </ReorgTableScope>
</DB2AutoReorgPolicy>
```

Automatic Compression Dictionary Creation

- Compression dictionary created automatically
  - Applies for INSERTs or LOADs
  - Dictionary created after threshold reached

- db2cmpd EDU finds and compresses uncompressed rows (BLU)

Automatic Compression - How it Looks

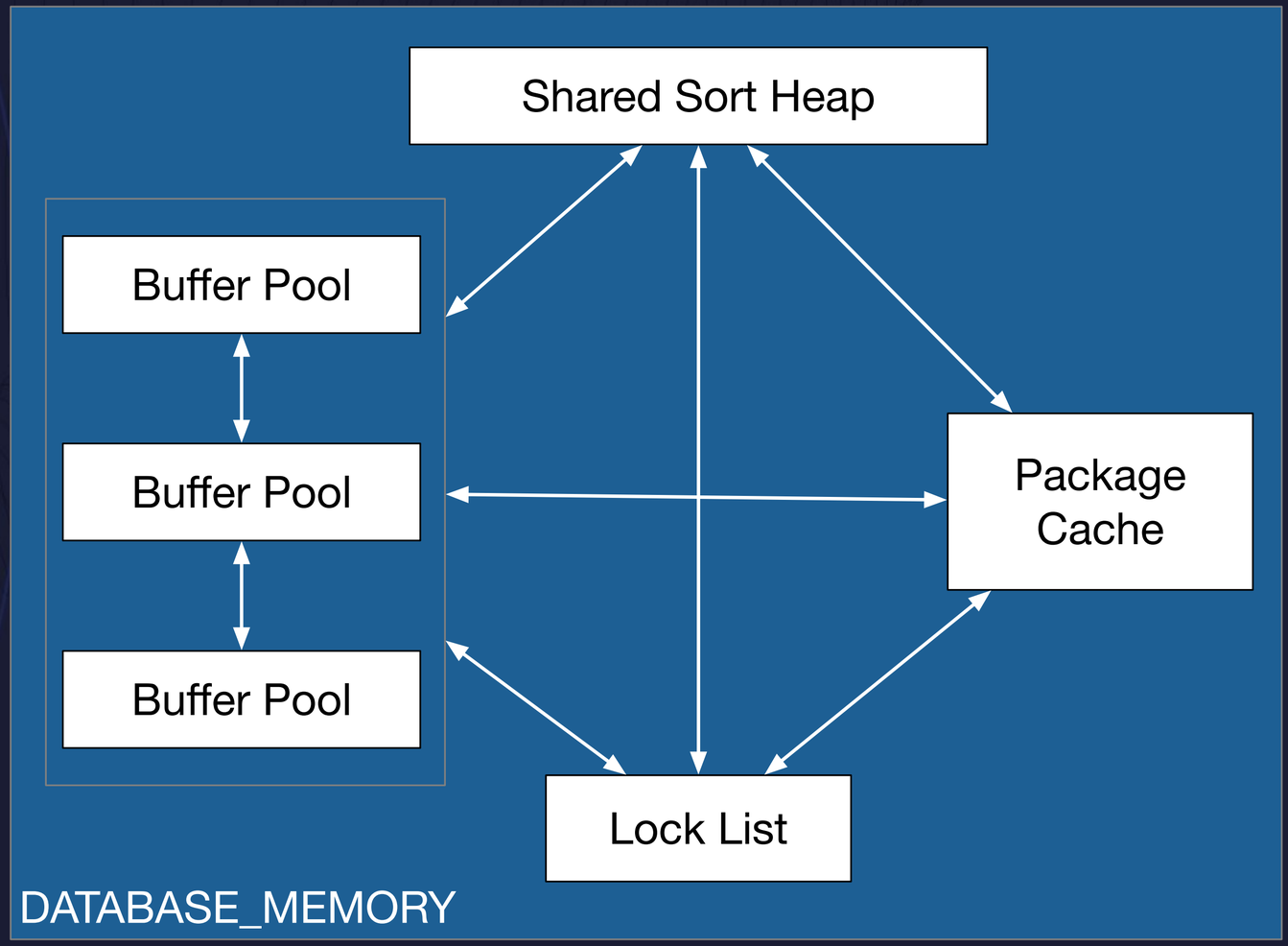


Self Tuning Memory Manager (STMM)

- Adjusts various memory consumers
  - Bufferpools
  - Locking Memory
  - Package Cache
  - Sort Memory
- Adjustments based on current conditions
- A true autonomic feature
- Available since DB2 9.1

STMM Memory Tuning

- Memory is moved between:
  - Buffer Pools
  - Lock List
  - Package Cache
  - Shared Sort Heap
- Database Memory can adjust based on OS memory conditions



STMM Memory Evaluation

- db2stmm EDU starts when database is activated
  - Every 30-300 seconds, it:
    - evaluates current conditions
    - performs cost/benefit calculations to adjust memory consumers
  - STMM Works iteratively
    - maximums are defined for increase/decrease on each iteration

Checking if STMM is Enabled

- Database Configuration Parameters
  - SELF_TUNING_MEM
  - DATABASE_MEMORY
  - LOCKLIST
  - MAXLOCKS
  - PCKCACHESZ
  - SHEAPTHRES_SHR
  - SORTHEAP

Checking if STMM is Enabled

- Bufferpools

```
$ db2 "select npages, bpname from syscat.bufferpools”
NPAGES      BPNAME
----------- ------------------------------------------
      10000 IBMDEFAULTBP
         -2 BP_8K
```

Enabling STMM

- Enable SELF_TUNING_MEM database configuration parameter

```
$ db2 update db cfg for SAMPLE using SELF_TUNING_MEM ON
```

- Set database configuration parameters to AUTOMATIC

```
$ db2 update db cfg for SAMPLE using \
      DATABASE_MEMORY AUTOMATIC \
      LOCKLIST        AUTOMATIC \
      MAXLOCKS        AUTOMATIC \
      PCKCACHESZ      AUTOMATIC \
      SHEAPTHRES_SHR  AUTOMATIC \
      SORTHEAP        AUTOMATIC
```

Enabling STMM

- Set bufferpool sizes to AUTOMATIC

```
$ db2 "alter bufferpool IBMDEFAULTBP size 10000 AUTOMATIC"
$ db2 "alter bufferpool BP8K size 10000 AUTOMATIC"
```

Getting Current Memory Consumer Sizes

- Database configuration parameters
  - GET DB CFG
  - db2pd -dbcfg

```
$ db2pd -db sample -dbcfg | \
     egrep 'Description|^LOCKLIST|PCKCACHESZ|SHEAPTHRES|^SORTHEAP|DATABASE_MEMORY'

Description                 Memory Value         Disk Value
DATABASE_MEMORY (4KB)       AUTOMATIC(113902)    AUTOMATIC(113902)
LOCKLIST (4KB)              AUTOMATIC(13824)     AUTOMATIC(13824)
PCKCACHESZ (4KB)            AUTOMATIC(1854)      AUTOMATIC(1854)
SHEAPTHRES_SHR (4KB)        AUTOMATIC(5000)      AUTOMATIC(5000)
SORTHEAP (4KB)              AUTOMATIC(1000)      AUTOMATIC(1000)
```

Getting Current Memory Consumer Sizes

- Bufferpools
  - db2pd -bufferpools

```
$ db2pd -db testdb -bufferpools | egrep 'Address|^0x' | \
     awk '{printf "%5s %-18s %9s %9s\n", $2, $3, $5, $NF}'

   Id Name               PA-NumPgs Automatic
    1 IBMDEFAULTBP            7500      True
    2 BP8K                    1000     False
 4096 IBMSYSTEMBP4K             16     False
 4097 IBMSYSTEMBP8K             16     False
 4098 IBMSYSTEMBP16K            16     False
 4099 IBMSYSTEMBP32K            16     False
```

Monitoring Autonomics

- Monitoring Automatic Maintenance
- Monitoring STMM

Monitoring Automatic Runstats

- Auto Runstats operations are not logged in db2diag.log
  - Logged in $DIAGPATH/events/db2optstats.*.log
  - Accessible with db2diag with **-fac optstats** option

Optimizer Statistics Log - Asynchronous Entry

```
$ db2diag -fac optstats -H 24h

2022-06-15-09.58.49.391713-240 E7202E708            LEVEL: Event
PID     : 24413                TID : 140596593288960 PROC : db2sysc 0
INSTANCE: db2inst1             NODE : 000            DB   : SAMPLE
APPHDL  : 0-12035              APPID: *LOCAL.db2inst1.220615135854
AUTHID  : DB2INST1             HOSTNAME: db2server
EDUID   : 6047                 EDUNAME: db2agent (SAMPLE) 0
FUNCTION: DB2 UDB, relation data serv, sqlrLocalRunstats, probe:12328
COLLECT : TABLE AND INDEX STATS : Object name with schema : AT
"2022-06-15-09.58.49.391680" : BY "Asynchronous" : start
OBJECT  : Object name with schema, 19 bytes
DB2INST1.ORDERITEMS
IMPACT  : None
DATA #1 : String, 10 bytes
RTS Daemon
```

Optimizer Statistics Log - Asynchronous Entry

```
$ db2diag -fac optstats -H 24h

2022-06-15-10.00.15.361313-240 E13452E861           LEVEL: Event
PID     : 24413                TID : 140596593288960 PROC : db2sysc 0
INSTANCE: db2inst1             NODE : 000            DB   : SAMPLE
APPHDL  : 0-12035              APPID: *LOCAL.db2inst1.220615135854
AUTHID  : DB2INST1             HOSTNAME: db2server
EDUID   : 6047                 EDUNAME: db2agent (SAMPLE) 0
FUNCTION: DB2 UDB, relation data serv, sqlrLocalRunstats, probe:15323
COLLECT : TABLE AND INDEX STATS : Object name with schema : AT
"2022-06-15-10.00.15.361267" : BY "Asynchronous" : success
OBJECT  : Object name with schema, 19 bytes
DB2INST1.ORDERITEMS
IMPACT  : None
DATA #1 : String, 10 bytes
RTS Daemon
DATA #2 : String, 122 bytes
RUNSTATS ON TABLE "DB2INST1"."ORDERITEMS" ON ALL COLUMNS WITH DISTRIBUTION ON ALL COLUMNS
AND SAMPLED DETAILED INDEXES ALL
```

Optimizer Statistics Log - Real Time Statistics Entry

```
2022-06-15-10.30.00.139407-240 E31381E666            LEVEL: Event
PID     : 24413                TID : 140586736674560 PROC : db2sysc 0
INSTANCE: db2inst1             NODE : 000            DB   : SAMPLE
APPHDL  : 0-9764               APPID: 172.24.31.21.37164.220615100127
AUTHID  : DB2INST1             HOSTNAME: db2server
EDUID   : 6501                 EDUNAME: db2agent (SAMPLE) 0
FUNCTION: DB2 UDB, relation data serv, sqlrLocalRunstats, probe:20
COLLECT : TABLE STATS : Object name with schema : AT "2022-06-15-10.30.00.139388" : BY
"Synchronous sampled" : start
OBJECT  : Object name with schema, 17 bytes
DB2INST1.BUSEVENT
IMPACT  : None
```

Optimizer Statistics Log - Real Time Statistics Entry

```
2022-06-15-10.30.00.463565-240 E32048E668            LEVEL: Event
PID     : 24413                TID : 140586736674560 PROC : db2sysc 0
INSTANCE: db2inst1             NODE : 000            DB   : SAMPLE
APPHDL  : 0-9764               APPID: 172.24.31.21.37164.220615100127
AUTHID  : DB2INST1             HOSTNAME: db2server
EDUID   : 6501                 EDUNAME: db2agent (SAMPLE) 0
FUNCTION: DB2 UDB, relation data serv, sqlrLocalRunstats, probe:60
COLLECT : TABLE STATS : Object name with schema : AT "2022-06-15-10.30.00.463497" : BY
"Synchronous sampled" : success
OBJECT  : Object name with schema, 17 bytes
DB2INST1.BUSEVENT
IMPACT  : None
```

Optimizer Statistics Log - Real Time Statistics Entry

```
2022-06-15-10.30.00.464184-240 E34053E656            LEVEL: Event
PID     : 24413                TID : 140586736674560 PROC : db2sysc 0
INSTANCE: db2inst1             NODE : 000            DB   : SAMPLE
APPHDL  : 0-9764               APPID: 172.24.31.21.37164.220615100127
AUTHID  : DB2INST1             HOSTNAME: db2server
EDUID   : 6501                 EDUNAME: db2agent (SAMPLE) 0
FUNCTION: DB2 UDB, relation data serv, sqlrLocalRunstats, probe:70
COLLECT : INDEX STATS : Object name with schema : AT "2022-06-15-10.30.00.464173" : BY
"Fabricate" : start
OBJECT  : Object name with schema, 17 bytes
DB2INST1.I0001104
IMPACT  : None
```

Understanding Automatic Statistics Frequency

```
select
   date(varchar(substr(first_eventqualifier, 1, 26), 26)) as date,
   count(*) as count
from
   table(sysproc.pd_get_diag_hist ('optstats', 'EX',
                'NONE', current_timestamp - 1 year,
                 cast(null as timestamp))) as sl
where
   objtype like '%STATS'
   and eventstate = 'start'
group by
   date(varchar(substr(first_eventqualifier, 1, 26), 26));
```

Understanding Automatic Statistics Frequency

```
DATE       COUNT
---------- -----------
06/15/2022         504
06/16/2022        1035
06/17/2022         828
06/18/2022         813
06/19/2022        2445
06/20/2022         835
06/21/2022         860

  7 record(s) selected.
```

Useful MON_GET functions

- MON_GET_AUTO_MAINT_QUEUE
  - List all queued automatic maintenance jobs
- MON_GET_AUTO_RUNSTATS_QUEUE
  - List all objects queued for statistics evaluation
- MON_GET_RTS_RQST
  - List all pending real-time statistics requests

Monitoring STMM

- STMM writes *changes* it makes to db2diag.log

```
$ db2diag -gi changeevent:=STMM

2022-04-01-17.14.36.590043-240 I48707841E566          LEVEL: Event
PID     : 36570                TID : 140608899376896 PROC : db2sysc 0
INSTANCE: db2inst1             NODE : 000            DB   : SAMPLE
APPHDL  : 0-72                 APPID: *LOCAL.DB2.220117064728
AUTHID  : DB2INST1             HOSTNAME: db2server
EDUID   : 140                  EDUNAME: db2stmm (SAMPLE) 0
FUNCTION: DB2 UDB, config/install, sqlfLogUpdateCfgParam, probe:20
CHANGE  : STMM CFG DB SAMPLE : "Sheapthres_shr" From: "998508" <automatic>  To: "821493"
<automatic>
```

Detailed STMM Log Files

- STMM writes log files with more details
  - Contains Cost/Benefit Details about changes
  - Written to $DIAGPATH/stmmlog/stmm.*.log
  - Files are limited to 10 Mb in size and only 5 files are kept

stmm.*.log Entry

```
2022-05-09-10.34.22.723120-240 I6814097E1036          LEVEL: Event
PID     : 27343                TID : 140651526088448 PROC : db2sysc 0
INSTANCE: db2inst1             NODE : 000            DB   : SAMPLE
APPHDL  : 0-8                  APPID: *LOCAL.DB2.210509133156
AUTHID  : DB2INST1             HOSTNAME: db2server
EDUID   : 44                   EDUNAME: db2stmm (SAMPLE) 0
FUNCTION: DB2 UDB, Self tuning memory manager, stmmLogRecordBeforeResizes, probe:594
DATA #1 : String, 535 bytes

***  stmmCostBenefitRecord ***
Type: BUFFER POOL ( LGT_DATA_BP )
PageSize: 8192
Saved Misses: 947114
Benefit:
  -> Simulation size: 1024
  -> Total seconds saved: 55 (+ 255441000 ns)
  -> Normalized seconds/page: 0.000149877
Cost:
  -> Simulation size: 1024
  -> Total seconds saved: 55 (+ 255441000 ns)
```

stmm.*.log Entry

```
***  stmmCostBenefitRecord ***
Type: BUFFER POOL ( LGT_DATA_BP )
PageSize: 8192
Saved Misses: 947114
Benefit:
  -> Simulation size: 1024
  -> Total seconds saved: 55 (+ 255441000 ns)
  -> Normalized seconds/page: 0.000149877
Cost:
  -> Simulation size: 1024
  -> Total seconds saved: 55 (+ 255441000 ns)
  -> Normalized seconds/page: 0.000149877
Current Size: 5010
Minimum Size: 5000
Potential Increase Amount: 2505
Potential Increase Amount From OS: 2505
Potential Decrease Amount: 0
Pages Available For OS: 0
Interval Time: 180.016
```

What's being changed

How much time is saved

Current size

How much it can increase

How much memory comes from OS (vs other Db2 memory areas)

parseStmmLogFile.pl

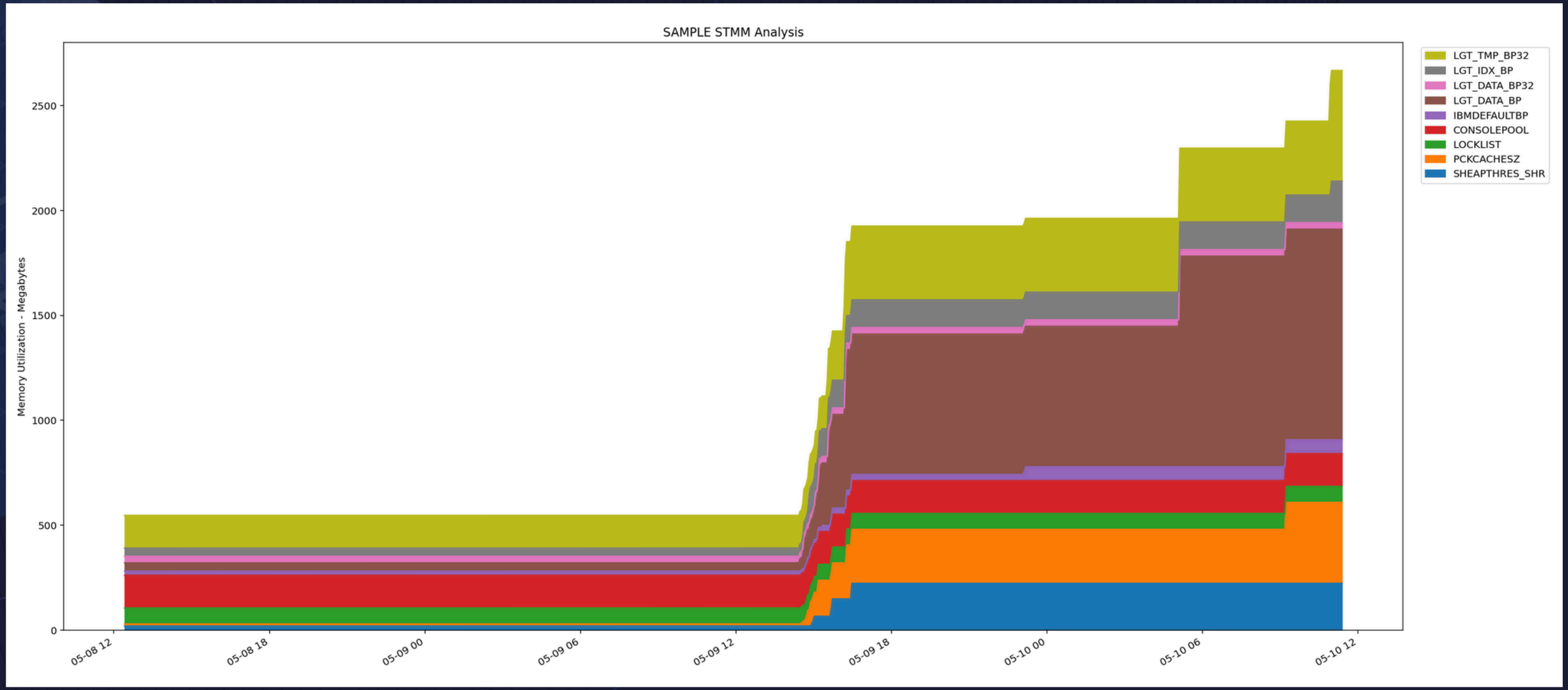
- Perl script that produces tabular view of STMM changes
  - Helpful for identifying how STMM moves memory
  - Can produce delimited files for graphing

- Used to be available on DeveloperWorks

parseStmmLogFile.pl Output

```
$ ./parseStmmLogFile.pl stmm.sample.log SAMPLE s | head
# Database: SAMPLE
[ MEMORY TUNER - LOG ENTRIES ]
[ Interv ] [        Date         ] [ totSec ] [ secDif ] [ newSz ]
[        ] [                     ] [        ] [        ] [ SHEAPTHRES_SHR  PCKCACHESZ  LOCKLIST  BUFFERPOOL -
CONSOLEPOOL:32K BUFFERPOOL - IBMDEFAULTBP BUFFERPOOL - LGT_DATA_BP:8K BUFFERPOOL - LGT_DATA_BP32:32K BUFFERPOOL -
LGT_IDX_BP:8K BUFFERPOOL - LGT_TMP_BP32:32K DATABASE_MEMORY  ]
...
[    521 ] [ 05/09/2022 14:25:31 ] [  93807 ] [    180 ] [ 5014 2568 19467 5002 5014 5010 1000 5003 5001 518434 ]
[    522 ] [ 05/09/2022 14:28:31 ] [  93987 ] [    180 ] [ 5014 2568 19467 5002 5014 7515 1000 5003 5001 535956 ]
[    523 ] [ 05/09/2022 14:31:31 ] [  94167 ] [    180 ] [ 5014 3852 19467 5002 5014 7515 1000 5003 5001 540954 ]
[    524 ] [ 05/09/2022 14:34:31 ] [  94347 ] [    180 ] [ 5014 5778 19467 5002 5014 7515 1000 7504 5001 550512 ]
[    525 ] [ 05/09/2022 14:37:31 ] [  94527 ] [    180 ] [ 5014 5778 19467 5002 5014 16908 1000 7504 5001 564849 ]
[    526 ] [ 05/09/2022 14:40:31 ] [  94707 ] [    180 ] [ 5014 8667 19467 5002 5014 16908 1000 7504 5001 569165 ]
[    527 ] [ 05/09/2022 14:43:31 ] [  94887 ] [    180 ] [ 5014 13000 19467 5002 5014 16908 1000 7504 5001 578708 ]
[    528 ] [ 05/09/2022 14:46:31 ] [  95067 ] [    180 ] [ 5014 19500 19467 5002 5014 16908 1000 7504 5001 586208 ]
[    529 ] [ 05/09/2022 14:49:31 ] [  95247 ] [    180 ] [ 5014 19500 19467 5002 5014 16908 1000 16884 5001 607390 ]
[    530 ] [ 05/09/2022 14:52:31 ] [  95427 ] [    180 ] [ 5014 29250 19467 5002 5014 16908 1000 16884 5001 614667 ]
[    531 ] [ 05/09/2022 14:55:31 ] [  95607 ] [    180 ] [ 7521 29250 19467 5002 5014 16908 1000 16884 5001 618432 ]
[    532 ] [ 05/09/2022 14:58:31 ] [  95787 ] [    180 ] [ 11281 29250 19467 5002 5014 16908 1000 16884 5001 624072 ]
[    533 ] [ 05/09/2022 15:01:31 ] [  95967 ] [    180 ] [ 16921 29250 19467 5002 5014 16908 1000 16884 5001 640988 ]
```

Jupyter Notebook STMM Visualization



Thank You

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