Customer Experience Taming DB2 Distributed Threads using System Profile Monitoring

Session 16973

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IBM – DB2 for z/OS

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#SHAREorg

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Customer Situation

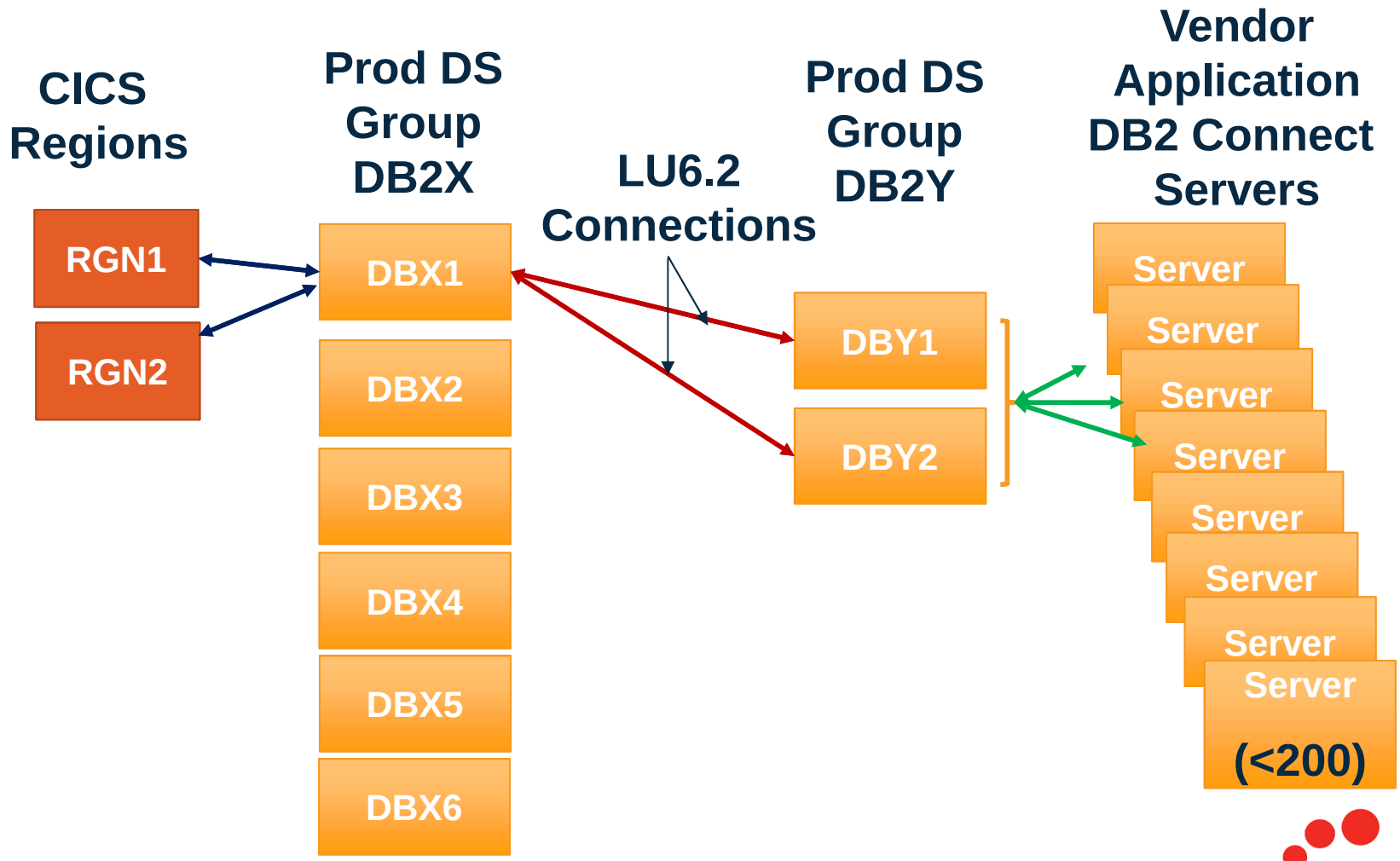
- Significant growth since 2003
  - Net effect was doubling the workload in the environment, then doubling it again, over the course of eight years

Description of Environment

- One data sharing group (DSG), DB2X, supports home grown applications
  - 6-way data sharing group
  - CICS activity from regions on 3 LPARs
  - TCP/IP DDF inbound activity
  - LU 6.2 outbound activity to DSG DB2Y and vendor application data

- Other data sharing group, DB2Y, supports vendor application
  - 2-way data sharing group
  - No CICS
  - DDF via TCP/IP
  - DDF via LU 6.2 from DB2X

Configuration – simplified view



DB2 to DB2 Connections

- SYSDDF tables
  - LOCATIONS
  - LUNAME
  - LULIST with both LU names for DB2Y in DB2X table
  - LULIST with all LU names for DB2X in DB2Y table

- DB2 Connect Servers
  - Cluster of servers
  - Spread work
  - Set up so subset of servers can handle all work
  - Means total threads can be > MAXDBAT!!

DB2 Configuration Settings

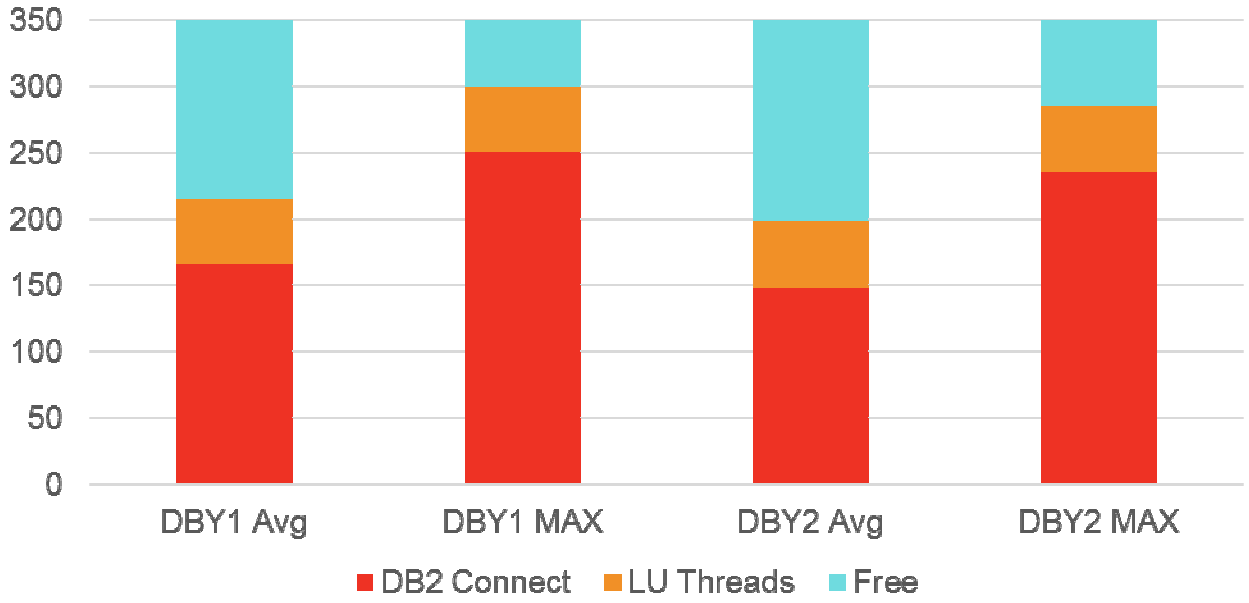
- DB2X
  - MAXDBAT=200
  - IDTHTOIN=0 → not really relevant to initial problem

- DB2Y
  - MAXDBAT=350 (350+350=700 in DSG)
  - IDTHTOIN=600
  - MAXDBAT ** Set in V8
  - MAXDBAT ** V9

- DB2 Connect Servers
  - MAX Connections=200 (8*200=1600)

DB2Y Threads

- Trends for DB2Y
  - DBY1 - Avg Threads=165 - Avg Max 250
  - DBY2 – Avg Threads=148 - Avg Max 235



DB2Y - What could go wrong?

- Diligent monitoring of AVG and MAX threads
- Monitoring was to anticipate need for 3-way data sharing
- Occasionally DB2Y would spike to 350 for short periods
- Prior to 2014, customer looked at options
  1. Evaluate DB2X->DB2Y access
  2. Expand DB2Y to 3-way
  3. Replicate data from DB2Y to DB2X to eliminate LU6.2

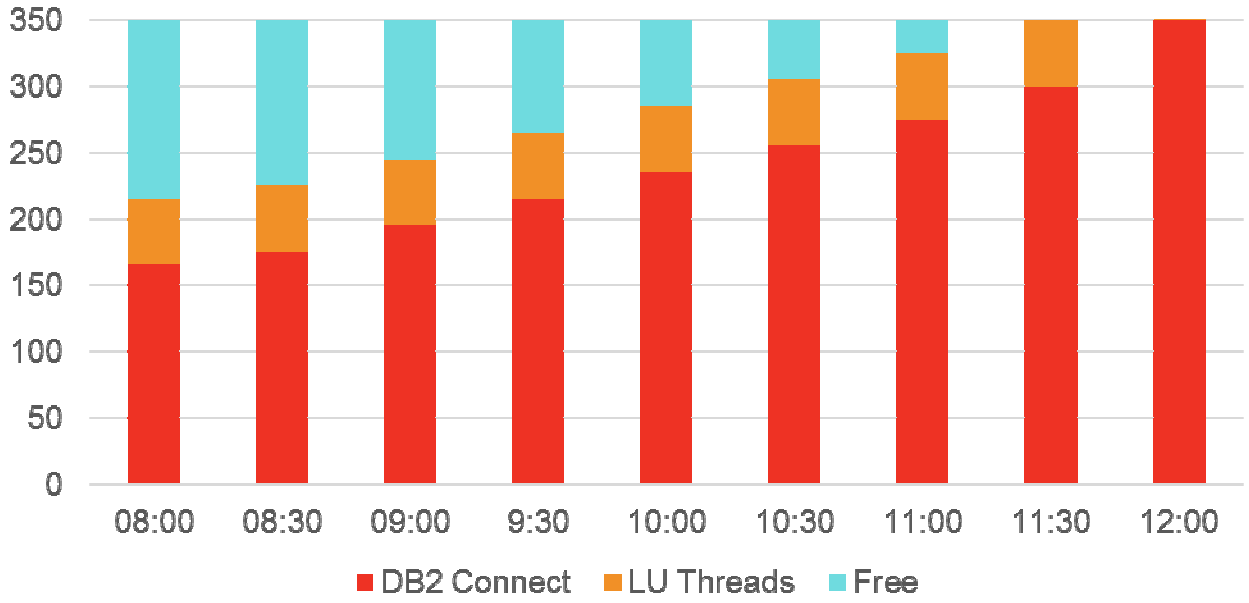
- Few problem occurrences considered not worth the “cost” of any changes

DB2Y - What just happened ?!?!

- DB2 V8/9 – MAXDBAT=350
- Upgrade to DB2 V10 in 2013 … Increase MAXDBAT??
  - Reviewed potential to increase MAXDBAT
- Dec 2013 - Server Problem ->threads started; did not end
  - DBY1 & DBY2 both went to MAXDBAT
- What happens when MAXDBAT reached??
  - Connections from DBX1/CICS get squeezed out
- CICS begins to hit MAXTASK and DB2X sees slowdown

DB2Y Threads

- When TCP/IP threads do not end
  - IP thread count grows
  - LU6.2 threads get “squeezed” out



DB2Y - First Reaction

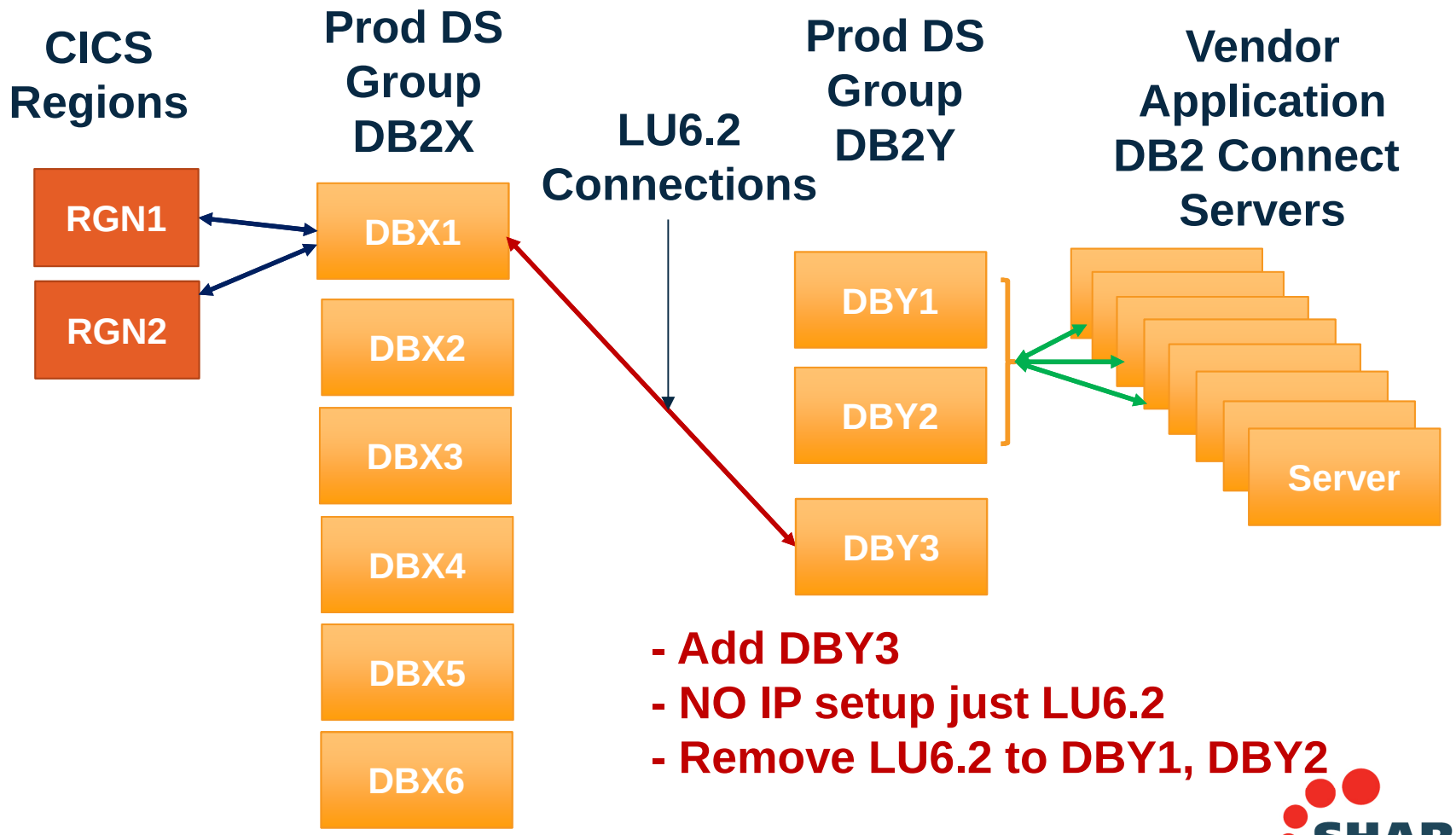
- MAXDBAT analysis … increase MAXDBAT
  - Option 1 -> increase MAXDBAT dynamically
    - Relieved pressure …. for short time
  - Option 2 -> Lower Idle Thread Timeout 10 min -> 2 min

  - MAXDBAT=450
  - MAXDBAT=700
  - MAXDBAT=800
  - MAXDBAT=1000
  - MAXDBAT=1200

DB2Y – Problems… again

- Application Issue
  - Another Server Issue
  - Caused DB2Y to hit MAXDBAT
  - MAXDBAT on DB2Y … caused MAXTASK in CICS
  - MAXTASK caused massive slowdowns
- Application issues, therefore DBA staff could not address
- Time for another look at options
  1. Replicate data from DB2Y to DB2X to eliminate LU6.2
  2. Expand DB2Y to 3-way (or 4-way) and put LU 6.2 to ‘DBY3’ (and ‘DBY4’), keep IP traffic to DBY1 and DBY2
  3. CALL IBM

Alternate Configuration Considered



- Add DBY3
- NO IP setup just LU6.2
- Remove LU6.2 to DBY1, DBY2

Options Reconsidered

- 1. Data replication from DB2Y->DB2X
  - Rejected: NOT an OPTION!!
- 2. Starting DBY3 was contemplated
  - Meant another subsystem member
  - Might require -
    - Creating Subsystem Alias
    - REBINDing PLANS
    - Modify COBOL that issued CONNECT
    - Modifying ALIAS with 3-part name to DB2Y

Option #3

- Contacted IBM and got meeting set up
- After listening to the problem, solution was
  - Use DB2 PROFILES
- Skeptical to say the least ->Too Simple
- If this worked, it would mean
  - No new subsystem
  - No VIEW or ALIAS changes
  - No subsystem ALIAS
  - No COBOL changes
- TOO GOOD TO BE TRUE

DB2 Profile Support

- 4 Tables
  - DSN_PROFILE_TABLE
  - DSN_PROFILE_ATTRIBUTES
  - DSN_PROFILE_HISTORY
  - DSN_PROFILE_ATTRIBUTES_HISTORY
- Define tables
- Load data to define profile(s)
- Issue START PROFILE command

DB2 Profiles - Testing

- Could not use development environment
- Used SANDBOX environment
  - Defined tables then defined profile for COLLECTION=NULLID & “maxdbat”=2
  - Issued START PROFILE
  - Used COMMAND LINE PROMPT windows
    - Connect and run query (with autocommit off)
  - 1st and 2nd window worked
  - 3rd window would “hang” … until one committed
- Successful test!!

DB2 Profiles – Testing (2)

- Moved to development environment
  - ZPARM MAXDBAT=700
- Dynamically set ZPARM MAXDBAT to 40
- Ran stress test (BASELINE)
  - When Active threads=40 ..
  - DDF threads began to queue …
    - Including LU6.2 threads

DB2 Profiles – Testing (3)

- Put ZPARM back to 700
- Defined tables and profile for COLLECTION=NULLID with “maxdbat”=40
- Issued START PROFILE
- Ran Stress Test
  - When Active threads hit 40 -> no impact to CICS
  - When Active IP threads hit 40 -> IP threads queued
  - No impact to LU 6.2 threads -> no impact to CICS regions
- SUCCESSFUL TEST!!

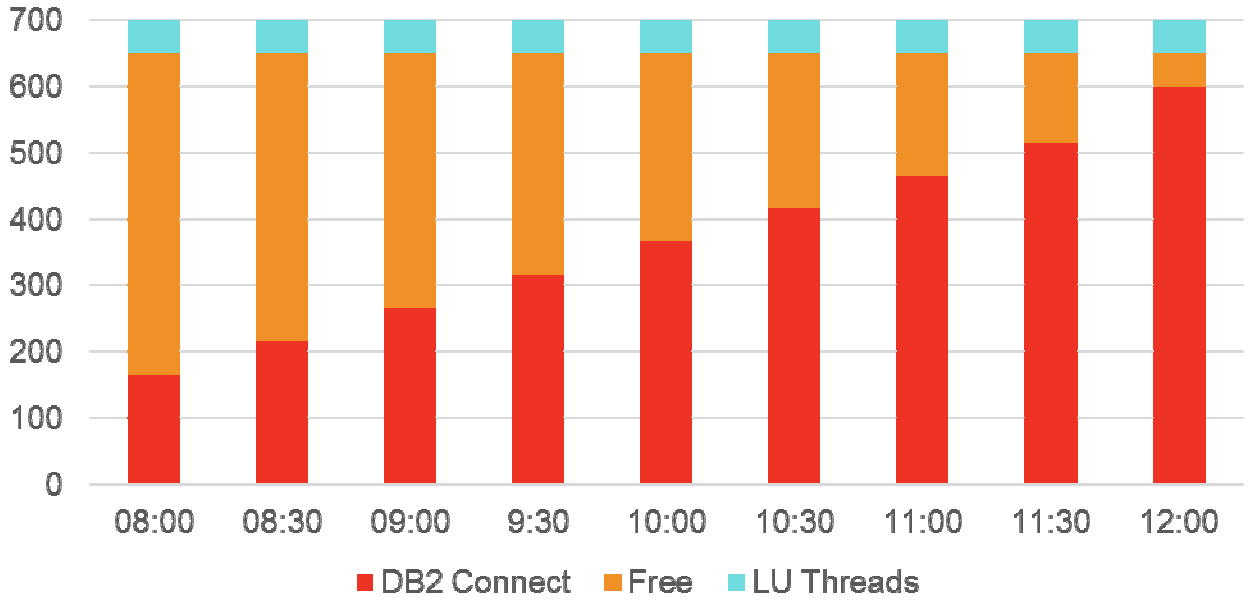
DB2 Profiles – Production

- MAXDBAT=700
- Defined tables then set up profile for COLLECTION=NULLID with “maxdbat”=600
- GOAL – “reserve” 100 threads for LU6.2 (from CICS)
- Set ZPARM IDTHTOIN (idle thread timeout) from 600 -> 115
  - Application saw no impact with lower timeout during incident

- Within 2 weeks, another server issue
- This time, no impact to CICS!
- SUCCESS!!!

DB2Y Threads

- When TCP/IP threads do not end
  - IP threads count grows
  - Make sure LU6.2 threads don’t get “squeezed” out



DB2 Profiles – Production

- PROFILE configuration working perfectly
- Minor problem with idle thread timeout reduction
  - Timeout “catching” weekly tasks
- Time to rethink reduction??

- Solution …. Update profile table!!!
- Add PROCESS IDs to profile and assign higher IDLE THREAD TIMEOUT value

DB2 Profiles – Summary

- Allowed us to control number of threads (by COLLID)
- Allowed us to set lower IDLE THREAD timeout for subsystem
- Allowed us to set higher IDLE THREAD timeout for specific IDs
- BENEFIT
  - No new subsystems
  - No application changes
  - Reduce risk to CICS regions
  - No software to purchase and/or install
- Lower IDLE THREAD Timeout -> Lower # threads active

DB2 Profiles – Options

- Any of the following combinations for monitoring connections, threads or idle threads, with particular rules for certain KEYWORDS values:
  - LOCATION only
  - PRDID only
  - AUTHID, ROLE, or both.
  - COLLID, PKGNAME, or both
  - One of CLIENT_APPLNAME, CLIENT_USERID, CLIENT_WORKSTNNAME
- Any column can be wild carded
  - Only “*” can be specified, enabling an “All” context for filtering
  - No “like” wild carding

DB2 Profiles – Options (2)

- Profile support allows you to
  - MONITOR CONNECTIONS
  - MONITOR THREADS
  - MONITOR IDLE THREADS

“System Profile Monitoring”

in DB2 10 and DB2 11 for z/OS

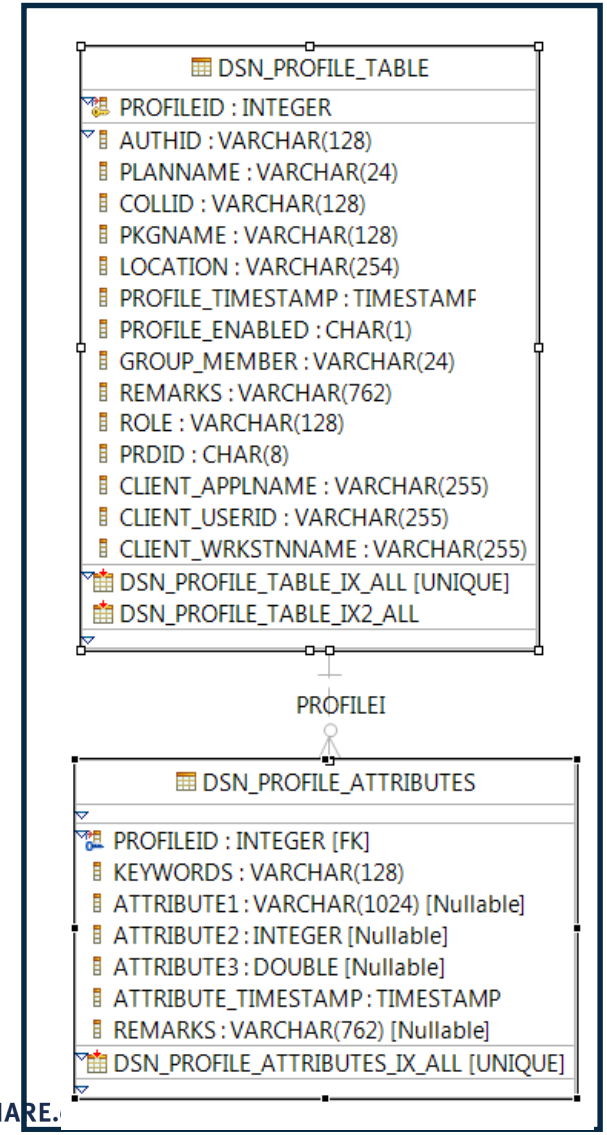
Overview of Profile Support in DB2 for z/OS

- Profiles allow you to:
  - Monitor remote threads and connections (TCP/IP) – DB2 10
    - MONITOR CONNECTIONS
    - MONITOR THREADS
    - MONITOR IDLE THREADS
  - Set or disable optimization parameters for SQL statements
  - Model your test environment after production
  - Set thresholds for Query Acceleration
  - Set special registers for distributed clients (DB2 11)

Overview of Profile Support in DB2 for z/OS

- SYSIBM.DSN_PROFILE_TABLE
  - Defines profile and filtering (e.g. LOCATION, PRDID, AUTHID, etc.)
    - Only certain combinations are allowed
    - Scope varies by the monitoring function specified in Attributes table
  - The PROFILE_ENABLED column indicates whether DB2 activates the profile when you start monitoring
- SYSIBM.DSN_PROFILE_ATTRIBUTES table
  - Defines attributes (e.g. MONITOR CONNECTIONS, MONITOR THREADS, MONITOR IDLE THREADS, etc.)
  - One or more attribute rows are required
  - Attribute rows control the actions that DB2 applies

Overview of Profile Support in DB2 for z/OS



Defining Profiles and Attributes

- Defining a profile
  - A row in SYSIBM.DSN_PROFILE_TABLE defines one filtering scope
    - Possible to have multiple rows defining more than one scope
    - In this example, the filtering category is ‘authorization identifier’ expressed in the AUTHID column (example value: DDS2364)
  - The PROFILE_ENABLED column indicates whether DB2 activates the profile when you issue the START PROFILE command

```
000003 INSERT INTO SYSIBM.DSN_PROFILE_TABLE ( AUTHID
000004                                       ,PLANNAME
000005                                       ,COLLID
000006                                       ,PKGNAME
000007                                       ,LOCATION
000008                                       ,PROFILEID
000009                                       ,PROFILE_TIMESTAMP
000010                                       ,PROFILE_ENABLED
000011                                       ,GROUP_MEMBER
000012                                       ,REMARKS
000013                                       ,ROLE
000014                                       ,PRDID
000015                                       ,CLIENT_APPLNAME
000016                                       ,CLIENT_USERID
000017                                       ,CLIENT_WRKSTNNAME)
000018 VALUES('DDS2364',  '',  '',  '',  ''
000019         ,101  ,  CURRENT_TIMESTAMP,  'Y',
000020        '',  '',  '',  '',  '',  '',  '' )
```

Defining Profiles and Attributes

- Defining actions
  - Rows in the SYSIBM.DSN_PROFILE_ATTRIBUTES table control the actions
    - The values of the PROFILEID columns of each table associate each profile with the corresponding actions for that profile (e.g.101)
    - The value in KEYWORDS column determines the action

```
000003 INSERT INTO SYSIBM.DSN_PROFILE_ATTRIBUTES ( PROFILEID
000004                                            ,KEYWORDS
000005                                            ,ATTRIBUTE1
000006                                            ,ATTRIBUTE2
000007                                            ,REMARKS)
000008 VALUES(101, 'MONITOR THREADS', 'WARNING_DIAGLEVEL2',
000009        '0' , '')
```

Defining Profiles and Attributes

- Starting and stopping profiles
  - You must enable and start profiles before DB2 can use the information in the profile tables
  - Issue a START PROFILE command
  - DB2 activates the functions specified in the profile tables for every valid row of the SYSIBM.DSN_PROFILE_TABLE table that contains PROFILE_ENABLED='Y'
  - Profiles in rows that contain PROFILE_ENABLED='N' are not started
- To stop monitoring, issue STOP PROFILE command
- Required authority: SQLADM, System DBADM, SYSOPR, SYSCTRL, or SYSADM

Defining Profiles and Attributes

- Validating profiles are ‘accepted’
  - Select from SYSIBM.DSN_PROFILE_HISTORY
  - Select from SYSIBM.DSN_PROFILE_ATTRIBUTES_HISTORY
  - Example:

```
SELECT * FROM SYSIBM.DSN_PROFILE_ATTRIBUTES_HISTORY;
ACCEPTED
ACCEPTED
ACCEPTED
REJECTED - THREAD-LEVEL MONITORING KEYWORDS USED FOR SYSTEM-LEVEL MONITORING SC

SELECT * FROM SYSIBM.DSN_PROFILE_HISTORY;
ACCEPTED
ACCEPTED
REJECTED - INVALID SCOPE SPECIFIED. FOR SYSTEM LEVEL MONITORING, ONLY LOCATION
```

Using Profile Support to Monitor DDF Resources

Why Profiles to Monitor DDF Resources?

- A single subsystem value means resources cannot be allocated by business area or priority
  - Vice President's request for connection or thread is equal to summer intern's request
  - Numerous low priority threads can reduce access for high priority threads
- Customers may be forced to use other means to prioritize or manage thread and connection requests
  - E.g. DB2 Connect Server Gateways instead of direct connections
- Single idle thread timeout may not reflect behavior of all application threads
  - E.g. entire subsystem may disable idle thread timeout because a single application cannot tolerate an idle thread timeout

Using Profiles to Monitor DDF Resource (1)

- Granular control – KEYWORDS column
  - MONITOR CONNECTIONS (relates to CONDBAT)
    - Total number of remote connections from TCP/IP requesters, including current active connections and inactive connections
    - Filtering on LOCATION column only: IP Address or Domain Name

Using Profiles to Monitor DDF Resource (2)

- Granular control – KEYWORDS column
  - MONITOR THREADS (relates to MAXDBAT)
    - Total number of concurrent active remote threads that use TCP/IP on the DB2 subsystem or member
    - Filtering on
      - LOCATION column (IP Address, domain name, location or location alias), or
      - PRDID, or
      - ROLE and/or AUTHID, or
      - COLLID and/or PKGNAME, or
      - One of CLIENT_APPLNAME, CLIENT_USERID, or CLIENT_WORKSTNNAME

Using Profiles to Monitor DDF Resource (3)

- Granular control – KEYWORDS column
  - MONITOR IDLE THREADS (relates to IDTHTOIN)
    - Approximate time (in seconds) that an active server thread is allowed to remain idle
      - A zero value means that matching threads are allowed to remain idle indefinitely
    - Same filtering as Monitor Threads
    - Can be set independently of IDTHTOIN – higher or lower

Using Profiles: Filtering Criteria

Client IP address or client domain name

1. Client IP address or domain name (defined in LOCATION column)

Client Product ID

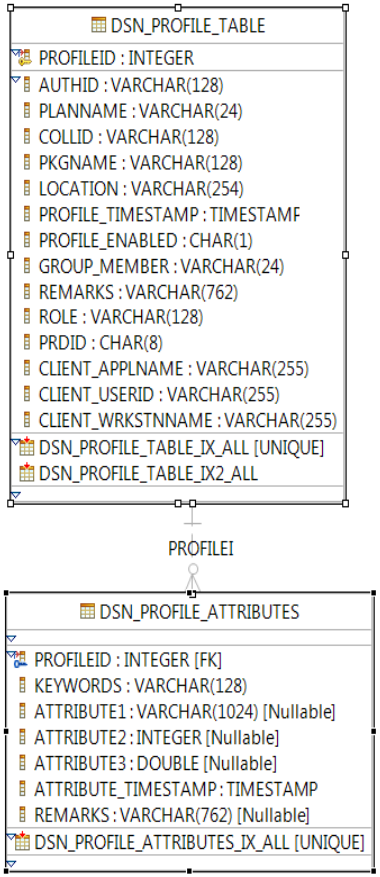
2. Client Product ID (defined in PRDID column)

Role name, Authorization ID

3. Role name + Authorization ID (defined in ROLE and AUTHID columns)
4. Role name (defined in ROLE column)
5. Authorization ID (defined in AUTHID column)

Collection ID, Package name

6. Collection ID + Package name (defined in COLLID and PKGNAME columns)
7. Collection ID (defined in COLLID column)
8. Package name (defined in PKGNAME column)



Criteria in these colored categories are mutually exclusive in a profile row; Choose one per profile row

Using Profiles: Filtering Criteria (2)

Location name or Location alias

9. Server location name or server location alias that Client tries to connect to (defined in LOCATION column)

Client Application Name

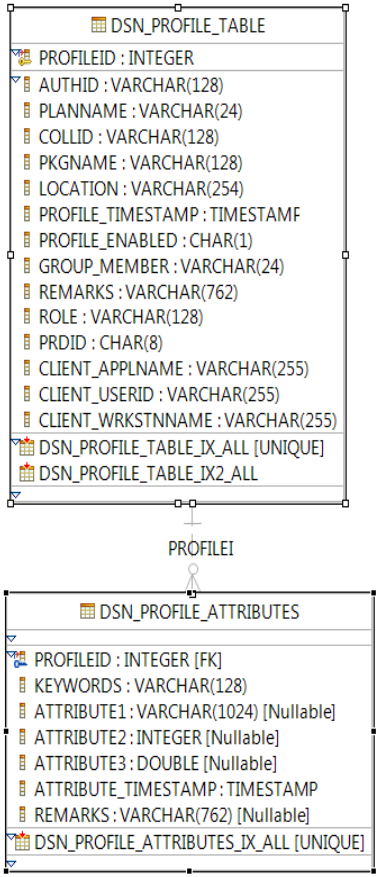
10. End Client Application name (defined in CLIENT_APPLNAME column)

Client User ID

11. End Client User ID (defined in CLIENT_USERID column)

Client Workstation Name

12. End Client workstation name (defined in CLIENT_WRKSTNNAME column)



Criteria in these colored categories are mutually exclusive in a profile row; Choose one per profile row

Using Profiles to Monitor DDF Resource (4)

- DSN_PROFILE_ATTRIBUTES table
  - ATTRIBUTE1 column specifies how DB2 responds when a threshold is met.
    - Action Taken:
      - WARNING - A console message is issued at most every five minutes.
      - EXCEPTION - If profile threshold is exceeded, DB2 takes action (the connection rejected, or thread queued, or thread canceled).
    - Messaging:
      - DIAGLEVEL1 (default) with minimal information
      - DIAGLEVEL2 includes PROFILEID and reason code
    - For example: WARNING_DIAGLEVEL1
  - ATTRIBUTE2 column specifies the threshold value
    - Number of connections or threads
    - Number of seconds for idle threads

Using Profiles: Column Details

- LOCATION column accepts three formats
  - IP address : IPv4 dotted-decimal (e.g. 9.1.2.3) or IPv6 colon-hex format (e.g. 2001:DB8::8:800:200C:417A)
  - Domain name, such as TEST.US.IBM.COM
  - Location name string: 1-16 byte string, such as STLEC1B
- GROUP_MEMBER column applies to members of a data sharing group
  - Blank: valid profile row applies to any member of the data sharing group
  - Non-blank: Value represents member name and valid row applies only to that member of the data sharing group
  - START PROFILE must be issued on each member of a data sharing group
- A single byte asterisk '*' placed in any of the filtering columns in DSN_PROFILE_TABLE defines a default filter scope

Using Profiles: Example Definitions

SYSIBM.DSN_PROFILE_TABLE

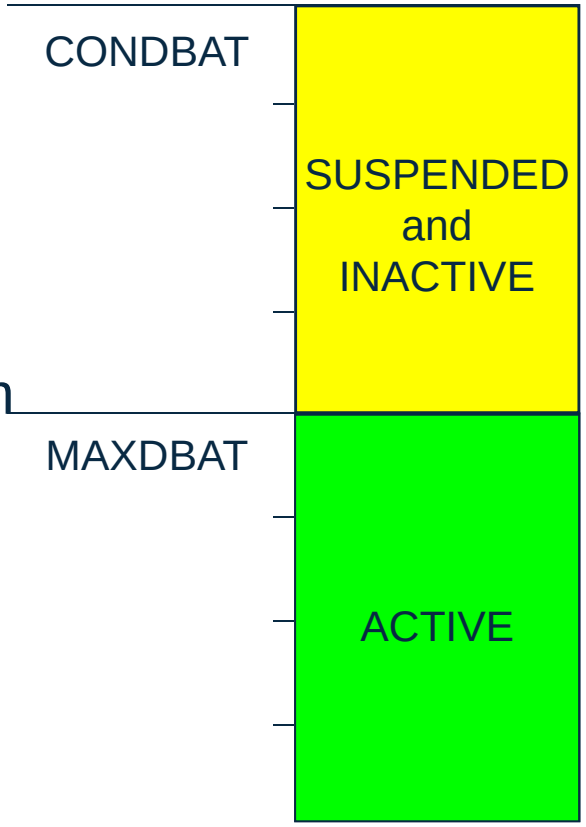
ROLE	AUTHID	LOCATION	PRDID	COLLID	PKGNAME	PROFILEID	PROFILE_ ENABLED
	PAYSRV					20	Y
			JCC03570			21	Y
		TEST.SVL.IBM.COM				22	Y

SYSIBM.DSN_PROFILE_ATTRIBUTES

ProfileID	Keywords	Attribute1	Attribute2	Attribute3	Attribute Timestamp
20	MONITOR THREADS	EXCEPTION	10		2011-12-19...
21	MONITOR IDLE THREADS	WARNING	180		2011-12-19…
22	MONITOR CONNECTIONS	EXCEPTION	45		2011-12-19…
22	MONITOR THREADS	EXCEPTION	20		2011-12-21…

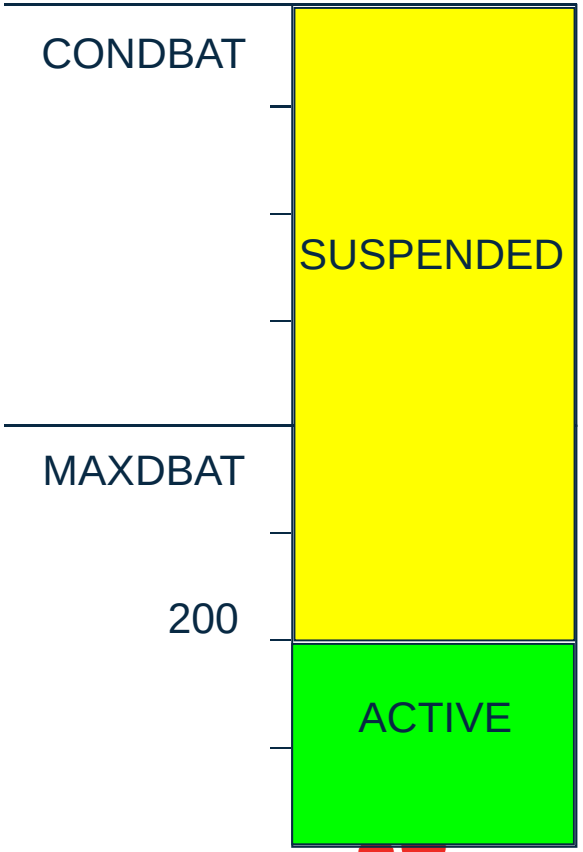
Monitor Threads and Connections (1)

- Results: Without Profiles
  - Number of active threads controlled by MAXDBAT
  - Number of connections controlled by CONDBAT
  - These values apply at the subsystem level and remain in effect



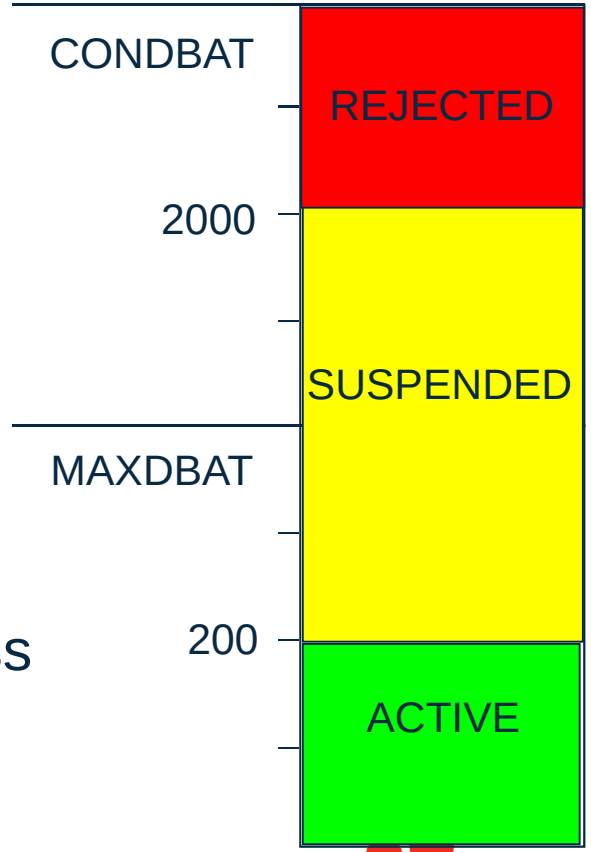
Monitor Threads and Connections (2)

- Results: Profile active: IP Address or Domain Name filter
  - Keyword: MONITOR THREADS
    - Attribute1: EXCEPTION
    - Attribute2: 200
  - Any thread requests *for this profile* in excess of 200 are suspended



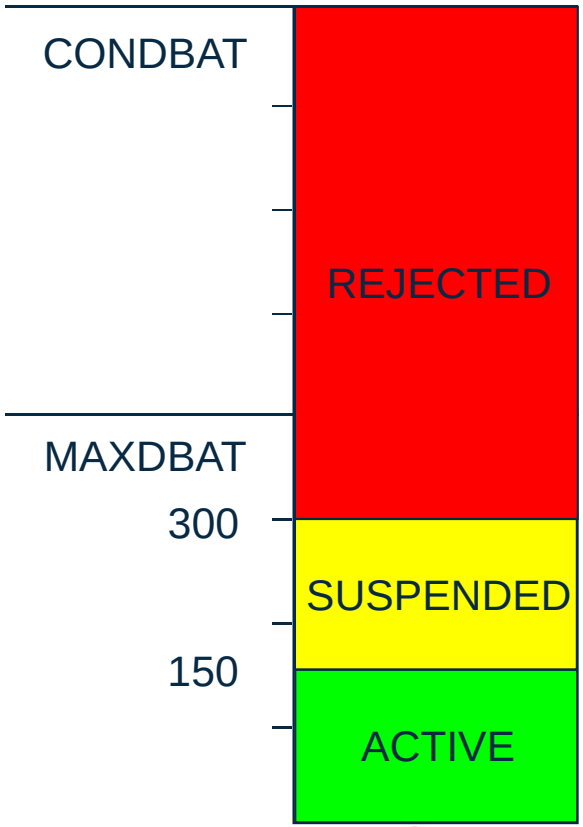
Monitor Threads and Connections (3)

- Results: Profile active: IP Address or Domain Name filter
  - Keyword: MONITOR THREADS
    - Attribute1: EXCEPTION
    - Attribute2: 200
  - Keyword: MONITOR CONNECTIONS
    - Attribute1: EXCEPTION
    - Attribute2: 2000
  - Any thread requests *for this profile* between 200 and 2000 are suspended
  - Thread requests *for this profile* in excess of 2000 are rejected with -30081 Communications Error



Monitor Threads and Connections (4)

- Results: Profile active: Any other filter (not IP Address or Domain Name)
  - Keyword: MONITOR THREADS
    - Attribute1: EXCEPTION
    - Attribute2: 150
  - Threads *for this profile* in excess of 150 are suspended
    - Until 150 are suspended
  - Threads *for this profile* in excess of 300 are rejected with -30041



Monitor Threads and Connections (5)

- Example with multiple KEYWORDS
  - PROFILEID 21 is associated with three keywords:
    - MONITOR THREADS – issue a message and suspend thread requests beyond 150 active DBATs
    - MONITOR CONNECTIONS – issue a message when there are more than 200 connections, but continue to service the connection requests.
    - MONITOR IDLE THREADS – issue a message and terminate threads idle for more than 30 seconds

PROFILE ID	LOCATION	ROLE	AUTHID	PRDID	COLLID	PKGNAME
21	DEMOMVS.DEMOPKG.IBM.COM	**null**	**null**	**null**	**null**	**null**

PROFILE ID	KEYWORDS	ATTRIBUTE1	ATTRIBUTE2	ATTRIBUTE3	ATTRIBUTE_TIMESTAMP
21	**MONITOR THREADS**	**EXCEPTION**	**150**	**NULL**	**2011-12-19…..**
21	**MONITOR IDLE THREADS**	**EXCEPTION**	**30**	**NULL**	**2011-12-17…..**
21	**MONITOR CONNECTIONS**	**WARNING**	**200**	**NULL**	**2011-1-21…..**

SQL Optimization Parameters,

Modeling Production in Test,

Setting Accelerator Thresholds

SQL Optimization Parameters

- Set or disable optimization parameters at a granular level
- Specify the subsystem parameter that you want to modify in the DSN_PROFILE_ATTRIBUTES table
  - KEYWORDS and Attributes
    - ZPARM NPGTHRSH
      - KEYWORDS = NPAGES THRESHOLD
      - ATTRIBUTE2 = number of pages
    - ZPARM STARJOIN
      - KEYWORDS = STAR JOIN
      - ATTRIBUTE1 = ENABLE/DISABLE
    - ZPARM SJTABLES
      - KEYWORDS = MIN STAR JOIN TABLES
      - ATTRIBUTE2 = number of tables

Model Production in Test Environment

- APARs and requirements
  - V9 APAR PM26475 & V10 APAR PM26973
    - Each APAR supports optimizer overrides for these system settings
  - New DSNZPARM parameters
    - SIMULATED_CPU_SPEED
    - SIMULATED_COUNT
  - SYSIBM.DSN_PROFILE_ATTRIBUTES KEYWORDS
    - SORT_POOL_SIZE
    - MAX_RIDBLOCKS
    - For bufferpools
      - Same as the BP names listed in the DSNTIP1 panel
      - BP0, BP1,…BP8K, etc.
- EXPLAIN will reflect “PROFILEID xxxx’ concatenated into REASON column of DSN_STATEMENT_TABLE

Setting Accelerator Thresholds

- In DB2 for z/OS Profiles have the ability to use these functional keywords to influence whether or not to send a query to an accelerator server
  - ACCEL_TABLE_THRESHOLD
    - Total table cardinality for a query to be treated as a short running query
  - ACCEL_RESULTSIZE_THRESHOLD
    - Maximum number of rows that a query that is sent to an accelerator server can return
  - ACCEL_TOTALCOST_THRESHOLD
    - Maximum estimated total cost for a query to be treated as a short running query
- Details are in the Managing Performance manual

DB2 11: Setting Special Registers for DDF Clients

Setting Special Registers for DDF Clients

- DB2 11 New Function Mode (PM93658)
- Profiles use same filtering categories as for monitoring threads and idle threads
- New KEYWORDS value: SPECIAL_REGISTER
  - ATTRIBUTE1 contains the ‘SET’ statement
  - E.g. SET CURRENT APPLICATION COMPATIBILITY = ‘V11R1’
- Precedence of the SET *special register*:
  - 1) Special register explicitly set by the application
  - 2) Special register set through Profile Support as above
  - 3) Special register set on the connection property level or data source level

Setting Special Registers for DDF Clients

- CURRENT APPLICATION COMPATIBILITY
- CURRENT DEBUG MODE
- CURRENT DECFLOAT ROUNDING MODE
- CURRENT DEGREE
- CURRENT EXPLAIN MODE
- CURRENT GET_ARCHIVE
- CURRENT LOCALE LC_CTYPE
- CURRENT MAINTAINED TABLE TYPES FOR OPTIMIZATION and CURRENT MAINTAINED TABLE TYPES
- CURRENT OPTIMIZATION HINT
- CURRENT PACKAGE PATH
- CURRENT PATH and PATH and CURRENT FUNCTION PATH
- CURRENT PRECISION
- CURRENT QUERY ACCELERATION
- CURRENT REFRESH AGE
- CURRENT ROUTINE VERSION
- CURRENT RULES
- CURRENT SCHEMA and SCHEMA
- CURRENT SQLID
- CURRENT TEMPORAL BUSINESS_TIME
- CURRENT TMEPORAL SYSTEM_TIME
- ENCRYPTION PASSWORD
- SESSION TIME ZONE and TIME ZONE

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