Continuous Availability in a Mobile World

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Agenda

• Connections and Threads
• Continuous Availability and Sysplex WLB
  • New algorithm
• Controlling Connections and Threads Manually
• RESTful Support in Db2

Ideal DBA reaction to 1 member of data sharing group crashing during online peak
Common terms

- What is a connection?
  - DRDA over TCP/IP = IP address (domain) and port resulting in an end-point or socket and a control block in DIST address space
    - Total number governed by ZPARM CONDBAT (default = 10,000 since V8)
      - At 80% of CONDBAT, DSNL074I message in MSTR log
      - If CONDBAT is exceeded, DSNL030I message in MSTR log and connection requests are rejected and DB2 cannot be accessed remotely
  - Socket not released until remote requestor closes connection
  - ZPARM TCPKPALV determines interval to ping socket to ensure connection is still there – avoid hung thread if connection drops
    - Default is 120 seconds
    - ENABLE means takes COMM Server default of 120 minutes
  - 2-4K in storage footprint above 2GB bar in DIST address space
    - Still have 210 bytes in Comm server ECSA
  - Max for CONDBAT has been 150,000 since DB2 V7
Common terms ...

- What is a database access thread (DBAT)?
  - Executed under WLM managed Enclave SRB mode
  - A DBAT is associated with a connection until the connection terminates
    - ZPARM MAXDBAT still 200 by default
      - If MAXDBAT is hit, DSNL092I in MSTR log and inbound requests queue up to CONDBAT, then requests rejected
    - ZPARM MAXCONQN limits the depth of the queue for a DBAT after MAXDBAT has been hit before being canceled/rerouted (default OFF)
    - ZPARM MAXCONQW limits the time a DBAT request remains queued until it is canceled/rerouted (default OFF)
    - ZPARM IDTHTOIN determines how long a thread remains active between issuances of SQL
      - Default 120 seconds
  - Storage in DBM1 (common range 12KB-2MB, or larger)
    - About 12KB in 31-bit private, the rest in 64-bit shared
    - -DIS THREAD(*) SERVICE(STORAGE) to see 31-bit usage
Thread pooling

• Thread pooling and inactive connection support
  • ZPARM CMTSTAT determines whether threads are disassociated with a connection at commit or at connection termination
    • CMTSTAT=INACTIVE (default as of V8)
      • At commit, threads are pooled to be reused by any new/resumed request
      • Connection becomes an inactive connection (formerly called a type 2 inactive DBAT)
        • Still holds a socket and counts against CONDBAT
      • ZPARM POOLINAC determines how long a DBAT remains unused in the pool
        • Default 120 seconds
    • CMTSTAT=ACTIVE
      • Thread stays associated with a connection until connection terminates
• Command -DIS THREAD(*) DETAIL for status
Inactive Thread Support (CMTSTAT=INACTIVE)

- Each inbound SQL request from distributed environments to the DB2 for z/OS server requires a DDF connection and a DB2 database access thread (DBAT)
  - MAXDBAT governs ALL DBATS (active + pooled)
    - IDTHTOIN governs time between last SQL issued and COMMIT
    - CONDBAT governs ALL connections (active + inactive)
- The benefits for DB2 z/OS Thread Pooling are:
  - CPU savings in DB2, by avoiding repeated creation and destruction of DBAT
  - Real memory savings in z/OS, by reducing the number of concurrent DBATs
  - Virtual storage savings in DBM1, by reducing the number of concurrent DBATs
  - Greater capacity to support DRDA connections
- Tangentially
  - Looking at Native RESTful services: PI86867 allows for persistent REST connections, reducing connection and thread management overhead
Thread pooling …

- The display DDF detail command gives a snapshot of the remote work going on
  - The presence of DSCDBAT proves the thread pooling is enabled
  - Ideally QUEDBAT and CONQUED will always equal 0
  - PKGREL BNDOPT or BNDPOOL allows the use of high performance DBATs
  - INADBAT is no longer related to Private Protocol, but indicates Monitor Threads profile exceptions
Customer Conns Rejected

- A connection storm or growth can occur when database access threads are not even consumed
- Need to monitor the number of inactive connections and ensure CONDBAT is never encroached upon
  - Sum inactive connections and active DBATS – issues if the inactive connections never leave
  - DSNL074I (at 80% of CONDBAT DB2 health lowered, only useful with Sysplex WLB) messages generally come too late to react
    - Ideally avoid this threshold to avoid ‘sloshing of work’
Who is connecting with what driver?

- Every customer needs an inventory of connections to tell: 1) How many, 2) if the drivers are in support and 3) what features they are exploiting
  - This should be repeated over time and tracked

- **DIS LOCATION DETAIL**
  - DSNL200I – JCC’ is the driver, SQL’ is DB2 Connect Server
    - **vv** A 2-digit number that identifies the product version number, such as 09 or 10.
    - **rr** A 2-digit number that identifies the product release level, such as 01 or 05.
    - **m** A 1-digit number that identifies the product modification level, such as 0 or 1
  - In the –DIS you can see the IP address it came from, product ID to let you know what level it is at.
    - The ATT column shows if the connection is using Sysplex WLB, XA two phase commit, or encryption (AES/ TLS)

### Example 2-2  DISPLAY LOCATION report

<table>
<thead>
<tr>
<th>PRID</th>
<th>T ATT CONNS</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>JCC03640</td>
<td>S</td>
<td>9.12.4.142</td>
</tr>
<tr>
<td>SQL09076</td>
<td>WLB</td>
<td>50</td>
</tr>
<tr>
<td>JCC03660</td>
<td>XA</td>
<td>50</td>
</tr>
<tr>
<td>JCC04160</td>
<td>-- 10.5 GA or FP1</td>
<td>--</td>
</tr>
</tbody>
</table>

---
What level of the driver is it?

- What level of the Driver equals what level of Connect?

- What driver level came through DB2 for z/OS maintenance stream

<table>
<thead>
<tr>
<th>PRDID</th>
<th>Sum of CONNS-TOT</th>
<th>Count of CONNS-TOT</th>
<th>Connect Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>JCC02100</td>
<td>5</td>
<td>5</td>
<td>JCC 2.10</td>
</tr>
<tr>
<td>JCC03500</td>
<td>0</td>
<td>3</td>
<td>JCC 3.50</td>
</tr>
<tr>
<td>JCC03530</td>
<td>614</td>
<td>43</td>
<td>JCC 3.53</td>
</tr>
<tr>
<td>JCC03640</td>
<td>21</td>
<td>9</td>
<td>JCC 3.64</td>
</tr>
<tr>
<td>JCC03650</td>
<td>0</td>
<td>3</td>
<td>JCC 3.65</td>
</tr>
<tr>
<td>JCC04090</td>
<td>510</td>
<td>21</td>
<td>JCC 4.9</td>
</tr>
</tbody>
</table>
Continuous Delivery

- New function/enhancements will be delivered via the maintenance stream in the form of new Function Levels
  - New SQL functionality available in V12R1M500…501, etc cannot be used until package is bound with APPLCOMPAT value of V12R1M50x
  - CURRENT APPLICATION COMPATIBILITY special register for dynamic SQL
  - clientApplCompat (in driver) is a prereq to connecting to the dynamic JCC packages (SYSLHx00, SYSSHx00, etc) once bound on FL501 and up
    - Downlevel clients (those without clientApplCompat will be rejected if NULLID collection is bound at FL501 and up
    - Also needed to exploit new features, i.e. LISTAGG
    - Use currentPackageSet driver property to point the connection at the correct collection ID
CONTINUOUS AVAILABILITY
How do I guarantee Continuous Availability?

• Ensure there is always an available connection to the data sharing group
  • Sysplex Distributor

• Ensure CONDBAT for the member, and across the group is never infringed upon by rogue/poorly behaving connections

• Control number and duration of connections via connection pool properties
  • Do you have control over these at all?

• Enable SysplexWLB (Sysplex Workload Balancing) in the IBM Data Server Driver to control the life cycle of the physical connection to Db2

• Route around failure of network connection, TCP/IP stack, Db2 member failure, LPAR/CEC failure

• Enable SysplexWLB (sysplex Workload Balancing) in the IBM Data Server Driver
High Availability – Sysplex Distributor

• Recommendation #1: Exploit Sysplex Distributor
  • Function of z/OS which serves to route incoming connections to target LPARs
  • Configure a Distributing Dynamic Virtual IP Address (DDVIPA) for the DB2 data sharing group
    • IP address owned by Sysplex Distributor
    • All members listen to this IP address for the SQL port
    • Connections are distributed across all members
    • Connections are successful as long as one member is up
    • Used by clients to access the group providing a single image
    • DISTMETHOD for Sysplex Distributor determines method of routing connections
  • Configure a DVIPA for each member
    • Member DVIPA is not distributed: routes connections to a specific member
    • Allows routing even if a member fails over to another LPAR using VIPA takeover
    • WLM weight and member DVIPA are provided to DB2 client driver for all registered subsystems
High Availability – Sysplex Distributor …

1. First connection goes through Sysplex Distributor (DVIPA) connecting to the group DVIPA
2. Sysplex Distributor routes based on DISTMETHOD
3. Result set (if Sysplex WLB is enabled) a list of available DB2 subsystems and their respective weightings are returned to the driver
4. Based on the respective weighting subsequent units of work are routed to the data sharing members (if Sysplex WLB is enabled) otherwise Sysplex Distributor decides

Vx = IP address of Group
W1, W2, W3 = relative weights of respective DB2 servers
DISTMETHOD

DISTMETHOD determines the logic Sysplex Distributor uses to route connections around the Db2 Data Sharing Group (Servers)

- Generally 3 methods
- **ROUNDROBIN** - recommended with enableSysplexWLB
  - Goes in order of PARMLIB member IEFSSNxx
- **BASEWLM** – takes into account
  - Displaceable capacity (at least 5% free)
  - **IWMSRSRS** function called by driver also uses:
    - Enclave performance and queue depth
    - Server WLM Health
- **SERVERWLM** - takes into account
  - Displaceable capacity to includes LESS important work, not absolute utilization
  - Enclave performance and depth
  - Abnormal termination rate
  - Server WLM Health

- Capacity planning around ‘white space’ favors BASEWLM

If the red workload is less important than your DDF work then SERVERWLM sees…
High Availability in the JCC Driver

- Availability is the key advantage to the IBM Data Server Driver (enableSysplexWLB = TRUE)
  - Automatic client reroute
  - Transaction level Sysplex Workload Balancing
- Automatic Client Reroute (ACR) - only available in driver
  - Connection to DB2 drops, seamless reroute connection at transaction boundary to other DB2 in data sharing group
- Sysplex WLB - transaction level balancing only available in driver
  - Every 10 seconds WLM refreshes list of optional DB2 members with relative weights
  - At transaction boundary next SQL can be routed to another member due to
    - Displaceable CPU on the LPAR
    - DB2 health
    - Enclave WLM Service class goal attainment and queuing
    - MAXCONQN / MAXCONQW
High Availability – Sysplex WLB …

• With ACR, application connectivity is *NOT* lost if DB2A is brought down or crashes
  • The intent is to route around connection failures and mask them from the applications
    • This also avoids stale connection exceptions in app server connection pools
  • If connectivity to DB2A is lost i.e. taken down for maintenance or crashes

  a) Driver receives network failure (-30108)
    • That transport would then be recycled to avoid being used by other requests
  b) Driver seamlessly routes transaction to another transport on another member
    • Logical connection 1 moves to transport 2
  c) Application receives no negative SQL code and continues processing
High Availability – Sysplex WLB …

- Without ACR, application connectivity is lost if DB2A is brought down or crashes (A)
  - Without Sysplex WLB, physical connection gets a stale connection exception
    - Driver receives network failure (-30108)
    - Application receives a stale connection exception
      - SQLCODE -4499 (JAVA) or SQL30108N (non-JAVA)
  - With ACR, if the failure occurs after the first SQL statement of a transaction (B)
    - Transaction rolled back in DB2
    - Driver (transport) receives network failure (-30108)
    - Connection is re-established to another member
      - Set statements replayed on connection
      - Application receives SQL code (SQL30108N)
        - Must re-drive SQL statement itself
Re-route-ability

• Use the Driver settings to further tune connections/timeouts if there are issues
  • **Only need to change enableSysplexWLB = false (default) → true (enableWLB: non-JAVA)**
    • Minimum recommended driver level is v9.7 FP6 or v10.1 FP2
  • maxTransportObjects (1,000 default)
    • TOTAL # transports * #drivers < (80%*CONDBAT) * DB2 Members of DS Group
  • maxTransportObjectIdleTime = 10 seconds (default)
    • This is how you get rid of inactive connections (like Aged timeout in WAS)
  • maxTransportObjectWaitTime, default is 1 second
    • SQLCODE -4210, SQLSTATE 57033 for connection waiting for a transport
  • maxRefreshInterval = 10 seconds (for WLM)

• Restrictions to connection (transport reuse)
  • If you declare global temporary tables, held cursors, they must be closed explicitly at transaction or branch boundary
  • JCC packages bound with - KEEPDYNAMIC(YES) or RELEASE(DEALLOCATE) would not reroute

• **Recommend using SD DISTMETHOD ROUNDROBIN with Sysplex Workload Balancing**
  • Sysplex Distributor only influences the initial connection and those rerouted when the driver’s list of servers is exhausted
  • If the list of servers has been exhausted and their health is ‘0’, we return to SD and may not want the most attractive member
Workload imbalance …

• Common problem: Why is my workload imbalanced?
  • Customers concerned about software pricing and controlling peak periods
  • Customers concerned about subsystems or LPARs becoming overloaded

• Enabling Sysplex WLB means the driver should distribute the work to the appropriate DB2 based on (IWMSRSRS WLM interface) **3 main factors:**
  • (#1) Displaceable capacity
    • Sysplex WLB favors LPARs with more CPs/zIIPs over smaller LPARs
      • ALSO system weight is divided by # of servers on it, so single member LPARs are favored
  • **Recommendation:**
    • Try to define and maintain a symmetric configuration
  • (#2) Performance index of enclaves as well as queue time
    • If threads delayed on LPAR 1 miss their WLM goal, they may ‘slosh’ to a DB2 on another LPAR
    • If the WLM goal is too loose the driver will not re-route work in a timely manner DBAT requests will queue
Workload imbalance …

- Enabling Sysplex WLB in the driver distributes the work based on IWMSRSRS WLM interface 3 main factors:
  - Recommendation:
    - WLM goals must be realistic and ACHIEVABLE i.e. may mean moving from Velocity to Response time goal
    - Monitor -DIS THREAD(*) DETAIL DSNV482I during peak times as well as RMF 72-3 Workload activity reports to determine effectiveness of the WLM policy and adjust if necessary
  - (#3) DB2 system health reported to WLM
    - Can be seen in DSNL094I WLMHEALTH=x And DSNV507I message below

- Recommendations:
  - Ensure active+inactive connections is < 80% of CONDBAT reached
    - At 80% (DSNL074I issued) health reduced to 50%, at 90% health reduced to 25%
  - Monitor 31-bit storage via IFCID 225 and maintain a cushion based on threads/data sets
    - DSNV508I issued at 88% of 31-bit private virtual storage consumed and DB2 health is lowered
  - Health also lowered if BOOSTS > 0
    - Monitor DSNV522I (PI29671) displays boosted agent
Workload balancing

- Sysplex Workload Balancing transaction distribution:
  - 2-member group
    - Member A has 25 active connections (in a UoW)
    - Member B has 10 active connections (in a UoW)
    - Member A weight = 30 / Member B weight = 10 (3:1 ratio)
  - Where would the next transaction be assigned?

  - Current ratios: (Member’s currently active transactions) / (Total active transactions for the group) <= (Member priority) / (Total of all member priorities)
    - Member A = active connections / total connections = 25 / 35 = 0.71 (which is < 0.75 target ratio)
    - Member B = 10 / 35 = 0.28 (which is > 0.25 target ratio)
    - Next transaction would be assigned to Member A
NEW Sysplex WLB algorithm

- Historically the distribution of transactions (accounting records) was not aligned with the designated relative WLM weighting.
- For consecutive trans the highest ranked system (member) would always receive the next transaction until it was loaded to its respective weight with concurrent transports, only then work would spread around the group.
- Customer experience:
  - SYS1 – DB2A Weight=10
    - 918 trans ~ 86%
  - SYS2 – DB2B Weight=6 & DB2C Weight=6
    - 182 trans ~ 14% combined
  - ** If > 1 member on LPAR weight is divided by # of subsystems.
- With a combination of long and short running transactions:
  - If long a tran ran first it would occupy the highest weighted member and the other trans would run on the next member.
  - Concurrency was needed to load balance the rest of the data sharing members.

### Old Algorithm

<table>
<thead>
<tr>
<th></th>
<th>Consecutive Short</th>
<th>1 long and consecutive short</th>
<th>Consecutive long and concurrent short</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB2A - 50%</td>
<td>100</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>DB2B - 25%</td>
<td>0</td>
<td>99</td>
<td>25</td>
</tr>
<tr>
<td>DB2C - 25%</td>
<td>0</td>
<td>0</td>
<td>25</td>
</tr>
</tbody>
</table>
NEW Sysplex WLB algorithm

- With Db2 Connect v11.1 M4 FP4 the algorithm will be adjusted
  - Upon the next getTransport() instead of starting over with the highest weighted member, the algorithm will resume where it left off in the list, thus ensuring workload is routed around the group based on the server listing preference
  - Some customers in the past have resorted to DISTMETHOD ROUNDROBIN in the Sysplex distributor, and turning off Sysplex WLB to more evenly distribute the work
    - **BUT** this only distributes work at a connection boundary, and will NEVER re-distribute those connections
    - Moving work to other servers requires net-new connections
  - **Customer experience: within 5% of ideal**
MANUAL CONNECTION/WORKLOAD MANAGEMENT
Cancelling Inactive Connections

- If you have inactive connections you can get rid of them one-at-a-time
- Display the inactive connections
  
  - DISPLAY THREAD(*) TYPE(INACTIVE) DETAIL
  
  V437-WORKSTATION=9.76.193.254  IP address
  V448--( 1) 446:53637  local and foreign ports

- Find the connection identifier (CONN) associated with the IP addresses for that local/foreign port combination:
  
  D TCPIP,,NETSTAT,conn,ipaddr=9.76.193.254
  USER ID    CONN        STATE
  DB1SDIST   162724E6 ESTBLSH  get the CONN identifier

- Drop the inactive connection which corresponds to that identifier:
  
  V TCPIP,,DROP,CONN=162724E6
Monitor profiles to limit threads/connections

- Catalog table holds profiles
  - DSN_PROFILE_TABLE
    - Describe threads/connection targets
  - DSN_PROFILE_ATTRIBUTES
    - What you limit and how

- Can limit:
  - Connections
  - Active threads
  - Idle thread timeout

- Limit based on
  - LOCATION only
  - PRDID only
  - AUTHID, ROLE, or both.
  - COLLID, PKGNAME, or both
  - One of CLIENT_APPLNAME, CLIENT_USERID, CLIENT_WORKSTNNAME

- Warning or Exception
  - 1 attribute could be warning (just once or for each threshold), another could be exception where incoming connections are queued or failed
  - DSNT77xI reason code 00E3050x with various degrees of detail
Limiting Total Connections

- Profile #1: Wildcard location so any remote IP address or location using more than 1,000 connections to any member writes a warning to the master log (DSNT773I)

- Profile #2: That IP address can only use up to 500 connections to a member where the profile is started, and the 501st is rejected with message DSNT774I reason code **00E30504**, and application receives **SQLCODE -30081**

- Could use Profiles to protect DB2 from connections spawned by application servers in a loop (garbage cleanup), poorly behaving application, or a denial of service attack

- **PI70250 added wildcarding and more granular messaging to V11**

<table>
<thead>
<tr>
<th>PROFILEID</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>*</td>
</tr>
<tr>
<td>2</td>
<td>9.76.193.254</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PROFILEID</th>
<th>KEYWORDS</th>
<th>ATTRIBUTE1</th>
<th>ATTRIBUTE2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MONITOR CONNECTIONS</td>
<td>WARNING_DIAGLEVEL3</td>
<td>1000</td>
</tr>
<tr>
<td>2</td>
<td>MONITOR CONNECTIONS</td>
<td>EXCEPTION_DIAGLEVEL3</td>
<td>500</td>
</tr>
</tbody>
</table>

Profile monitoring …

• DSN_PROFILE_ATTRIBUTES
  • Within V11 and PI31957 there are three levels of detail for each type
    • TYPE_DIAGLEVEL3 (in PI31957) – includes DSNT772I with detailed information about what filtering criteria triggered the WARNING/EXCEPTION plus thread and connection information when available
      • Issued once per occurrence – so you would need to alter and stop/start profile if it floods the console OR start IFCID 406 for detailed tracing without the flood of messages
      • This would be very useful for testing as well as cases where ‘well-behaved’ applications grow
        • DSNT772I +
        • DSNT773I – for warning
        • DSNT774I – for exception

```
DSNT774I  -DB2B DSNLAGNT SERVER DISTRIBUTED AGENT 732 WITH
  LUWID=G91EDE68.G403.000000000000
  THREAD-INFO=-UNKNOWN:*:*:*:*:*:*:*:
FOR LOCATION=::FFFF:9.30.222.104
RECEIVED MONITOR CONNECTIONS EXCEPTION
DUE TO PROFILE ID=4
```
Introduction to REST services

- **REST** — "Representational State Transfer" … which uses HTTP/HTTPS and HTTP/HTTPS verbs to allow a client to interact with a server over the TCP/IP network
  - Use HTTP verbs for Create, Read, Update, Delete (CRUD) operations

- **JSON** — “JavaScript Object Notation” … a name/value pair representation of data that is relatively lightweight and generally simpler to handle and parse than XML.
  - An architectural style for accessing and updating data
  - Simple and intuitive for the end customer (the developer)

*In Db2: THINK little ‘b’ stands for microservices*
Db2 REST services support …

• Only need a REST client to access/query/invoke the service (*No driver you ask?*)
  • Plug-in for almost any web browser
    • GET used for discovery
    • POST used to invoke service
• Can be created manually or with Data Studio
  • Use DB2ServiceManager REST service
    • POST statement to create or Drop/free to remove it
  • OR use BIND SERVICE/ FREE SERVICE
    • BIND SERVICE(*collection-id*) NAME(*service-name*) [SQLDDNAME(*ddname*)]
• Service constitutes a single SQL statement (SELECT, INSERT, UPDATE, DELETE, CALL)
  • Could also be a call statement to invoke a procedure or UDF
• New SYSIBM.DSNSERVICE table describes REST services
• Instead of NULLID collection SYSLH100 packages, etc. for dynamic SQL → SYSIBMSERVICE is invoked
  • Product ID HTP01010 or HTS01010 shown in –DIS LOCATION
• Db2 manages parsing the JSON payload inbound/outbound
Db2 RESTful services support ...

HTTP Request
POST http://mybank.com:4711/services/ACCOUNTS/getBalance
Body: { "ID": 123456789 }

HTTP + JSON

DDF
- HTTP and JSON parsing
- Security Checks
- Thread Creation

Db2
- SQL execution

SELECT BALANCE FROM BANK.ACCOUNTS WHERE ID=123456789

HTTP Response
Body: { "BALANCE": 1982.42 }
Db2 Native RESTful Service Support …

- CREATE or DROP Service using either Data Studio support or direct REST service call to DB2ServiceManager
  
  POST https://<host>:<port>/services/DB2ServiceManager
  
  {"requestType": "createService"}...

- Discover all services and discover details for a specific service using direct service call to DB2ServiceDiscover
  
  POST https://<host>:<port>/services/DB2ServiceDiscover

- Db2 RESTful service invocation.
  - DB2 Adapter for z/OS Connect V1 invocation API syntax
  - DB2 native REST invoke API
Db2 Native RESTful Service Support …

- Db2 REST service commands
  - Added in PI98649 – Db2 11 & 12
    - Display services
      - The Db2 command to display the status of REST services that exist in Db2.
      - `DISPLAY RESTSVC(collection-name.service-name) STATUS(*) LIMIT(*) SCOPE(--group--)`

```
DSNL601I -DB2A DISPLAY RESTSVC REPORT FOLLOWS-
DSNL610I -DB2A ---- COLLECTION=BankDemo
SERVICE CreateAccount
        DepositById
        DisplayAccountByld
        DisplayAcctTranHistory
        DisplayAllAccounts
        TransferBetweenAccounts
DSN9022I -DB2A DSNLJDSS 'DISPLAY RESTSVC' NORMAL COMPLETION
```

- Start services
  - The Db2 command to start the definition of a REST service that has been stopped.
  - `START RESTSVC(collection-name.service-name) SCOPE(--group--)`

- Stop services
  - The Db2 command to stop accepting any new discover details or invoke request for a REST service.
  - `STOP RESTSVC(collection-name.service-name) ACTION(REJECT) SCOPE(--group--)`
Display of Db2 Native REST service locations and threads

• You can issue the –DISPLAY THREAD(*) command and the correlation ID for a thread that processes a service is set to “DB2_REST” while the application name is the name of the service that is invoked

• –DISPLAY THREAD(*) also identifies which REST GET/POST statement calling “birthDayList” service

• The User-Agent field in the REST header can be customized, here it is WORKSTATION=‘agb’
References

- Db2ZAI - Db2 Artificial intelligence in the optimizer
  - https://www.youtube.com/watch?v=t5fTNxfehQA
- Keyword search “DB2REST”, Info APAR – II14827
- Techdoc for V10 and V11 MEMU2 with spreadsheet sample
  - https://www-01.ibm.com/support/docview.wss?uid=tss1prs5279
- DB2 for z/OS and WebSphere Integration for Enterprise Java Applications
- Subsystem and Transaction Monitoring and Tuning with DB2 11 for z/OS
- Upcoming Webcasts - World of DB2
Db2ZAI Announcement

- Db2 for z/OS Artificial Intelligence (AI) was announced on Sept 11\textsuperscript{th} 2018
- User interface and code to connect with IBM Machine Learning for z/OS
- Determine best access path for queries with host variables/parameter markers via learning their patterns

**IBM Db2 AI for z/OS — Business Value**

Db2z infused with ML

ML for z/OS

IBM Z

\[ \text{Up to 25\% CPU Savings}^* \]

\#Db2ZAI
Thank You
(??’s)