Stored Procedures FAQS

1. What are the advantages of stored procedures

- SQL traffic is reduced
- Lock duration is short
- Code reuse
- End users do not require access to base tables

---

2. What are the stored procedure Address space types.

DB2-Established

- One address space for DB2 subsystem with multiple tasks
- Limited function -- has not been enhanced since V5
- Must use Call Attach **DSNALI –** DSNHADDR program

WLM Established

- Applications can be grouped by environment
- Multiple address spaces in each environment
- Can have multiple tasks in each address space
- Dispatching priority is inherited from caller (includes support for period switching)
- Individual JCL procs for each environment
- Improves stored procedure program isolation
- User programs must be AMODE(31)
- Must use RRS Attach **DSNRLI –** DSNHLIR program

  eg.,

```
//SYSIN    DD  *
           INCLUDE SYSLIB(DSNRLI)
           NAME LPRSP002(R)
/*
```

---

3. What is a WorkLoad Manager?

Workload Manager (WLM) is a component of OS/390; it is a solution for managing workload distribution and distributing resources to workloads. Check for a process called WLM in your SDSF active panel, and if you find a process called WLM operating, your shop has implemented WLM. WLM has two modes of operation**: goal mode and compatibility mode**.

In goal mode, WLM can fire up address spaces on its own to meet demand. This is critical for version control, since we need more than one address space for supporting multiple versions of the stored procedure.

In compatibility mode, the address spaces are started manually.

WLM is the only means by which we can have multiple stored procedure address spaces in a DB2 subsystem; that is why it is the key part of this implementation.

---

4. What are Schemas ?

Schemas, are a handy way to group objects together. The objects could be stored procedures, triggers, or functions. Objects are created into a "Schema" and use the Schema name as the qualifier. This name extends the concept of "Qualifier" to these relatively new objects. Using multiple schema names is central to the idea to establishing multiple WLM-managed stored procedure address spaces, since only with multiple schema names can one define multiple stored procedure definitions having different WLM environment names.

Stored Procedures FAQS

5. What is Resource Recovery Services (RRS)?

Resource Recovery Services (RRS) is an MVS feature that coordinates two-phase commit processing. It's a system-logger application that records events related to protected resources.

If your shop has implemented WLM, check for a process called RRS in your SDSF active panel. WLM-managed stored procedure address spaces utilize RRS attachment facility (RRSAF) to interface with DB2, not the Call attach Facility (CAF). Thus stored procedures executing in traditional DB2-managed address spaces will need to be recompiled for the WLM environment.

---

6. What are the definitions needed to create WLM managed stored procedures

Workload: A group of related work meaningful for the installation. All the work started by a set of applications is a workload. We could define a workload for exclusively stored procedures.

Service definition: One set of definitions of your workload and its performance goals.

Service policy: A set of service policies is a service definition. Only one service policy can be active at any given time. That is, DAYTIME service policy is active during the day, while a NIGHTTIME policy is active during the night.

Service class: Classification of work that has the same performance characteristic. It is by the mechanism of the CLASSIFICATION RULE that WLM associates a service class with a piece of work that arrives at a subsystem.

Service class period: Makes up a SERVICE CLASS. This definition has performance objectives. The service class period has three attributes:

> ***Importance:*** How important is the work?
>
> ***Goal:*** Response time or Execution velocity. OLTP transactions have a response time goal, whereas batch typically gets a velocity goal.
>
> ***Duration:*** Determines for how long the task will receive the level of importance and the specified goal.
>
> **Application environment:** The most important definition related to stored procedures; it is probably the only definition that a DBA will need. An AE definition represents one or more stored procedures. It is a way to have WLM dynamically create and delete server address spaces.

---

7. How to Create an application environment ?

To implement version control with WLM, we will have to create AE definitions in the existing SERVICE DEFINITION installed in your shop. Your systems programmer will need to grant you authorization to read the existing service definition. After you save this in a dataset, you can add the AE definitions, and then have the systems programmer install the modified service definition.

The ISPF application supplied to create and modify WLM definitions is typically in SYS1.SBLSCLI0 (IWMARIN0). Executing this application displays the following screen.

After extracting and saving this service definition in a dataset, use option 9 on this screen to create a new AE definition

Use the following values for the new AE definition. The procedure name referred to is the JCL procedure name in SYS1.PROCLIB. This is the procedure that WLM will use to initiate an address space when there is demand for one. For version control we need to have three AEs invoking three different JCL procedures (with different load libraries).

Sample DB2 Stored Procedure Address Space (SPAS) JCL

```
//DSN7SPAS PROC RGN=0K,TME=NOLIMIT,DB2SSN=DBDD,NUMTCB=8
//SPASPROC EXEC PGM=DSNX9STP,REGION=&RGN,TIME=&TME,
// PARM='&DB2SSN,&NUMTCB'
//STEPLIB     DD DISP=SHR,DSN=DBDD.DBA.DB2.RUNLIB
//            DD DISP=SHR,DSN=DBDD.DBA.DB2.DSNLIB
//            DD DISP=SHR,DSN=DBDD.DBA.DB2.SP.LOADLIB
//            DD DISP=SHR,DSN=CEE.SCEERUN
//DSNAOTRC    DD DISP=SHR,DSN=DBDD.DBA.DB2.TRACE
//CEEDUMP     DD SYSOUT=X
//SYSOUT      DD SYSOUT=*
```

Sample WLM-Managed Stored Procedure JCL

```
//D71AWLMJ PROC RGN=0K,APPLENV=D71AWLMJ,
//         DB2SSN=D71A,NUMTCB=1
//*****************************************************************
//IEFPROC EXEC PGM=DSNX9WLM,REGION=&RGN,
//     TIME=NOLIMIT,'PARM='DBDD,8,DBDDENVU'
//*****************************************************************
//* RGN       - THE MVS REGION SIZE FOR THE ADDRESS SPACE.
//* DB2SSN    - THE DB2 SUBSYSTEM NAME.
//* NUMTCB    - THE NUMBER OF TCBS USED TO PROCESS END USER REQUESTS
//* APPLENV   - THE MVS WLM APPLICATION ENVIRONMENT
//*****************************************************************
//STEPLIB     DD     DISP=SHR,DSN=DBDD.DBA.DB2.RUNLIB
//            DD     DISP=SHR,DSN=CEE.SCEERUN
//            DD     DISP=SHR,DSN=DBDD.DBA.DB2.DSNLIB
//            DD     DISP=SHR,DSN=UNT.CHAINA.OBJ.LOADLIB
//            DD     DISP=SHR,DSN=STG.CHAINA.OBJ.LOADLIB
//            DD     DISP=SHR,DSN=CAT.CHAINA.OBJ.LOADLIB
//            DD     DISP=SHR,DSN=TPD.OBJ.LOADLIB
//            DD     DISP=SHR,DSN=DBDD.DBA.DB2.SP.LOADLIB
//            DD     DISP=SHR,DSN=EQAW.SEQAMOD
//*****************************************************************
//SYSTCPD     DD     DSN=TCPIP.USER.SEZAPARM(IPDDV1),DISP=SHR
//* LE runtime library should be placed in LNKLST
//CEEDUMP     DD SYSOUT=*
//SYSPRINT    DD SYSOUT=*
//SYSOUT      DD SYSOUT=*
//ERRLOG      DD SYSOUT=*
//ERRLOG2     DD SYSOUT=*
//SYSABEND    DD SYSOUT=*
//SYSUDUMP    DD DUMMY
```

---

8. How to maintain WLM-established address spaces ?

Following are some of the commands that a DBA needs to be familiar with in order to manage WLM-established address spaces. These commands are issued on the SDSF log or on the operator console.

To Display status of a Application environment	**D WLM, APPLENV=TDB2WSPD**
To Start an Application environment	**VARY WLM,APPLENV=TDB2WSPD,RESUME**
To Stop an Application environment	**VARY WLM,APPLENV=TDB2WSPD,QUIESCE**
To Refresh modules in an Application AE	**VARY WLM,APPLENV=TDB2WSPD,REFRESH**

Stored Procedures FAQS

9. What is the processing flow of Stored Procedure execution?

1. A thread must be created for each application that needs DB2 services. If the application is local, the thread is created when the first SQL statement is executed. If the request comes from a remote client, the thread is created when the client application issues the SQL CONNECT statement. After the thread is created, SQL statements can be executed.

2. When a client application issues an SQL CALL statement, the stored procedure name and the I/O parameters are passed to DB2.

3. When DB2 receives the SQL CALL statement, it searches in the SYSIBM.SYSPROCEDURES catalog table for a row associated with the stored procedure name. From this table, DB2 obtains the load module associated with the stored procedure and related information.

4. Stored procedures are executed in address spaces. From DB2 5, in addition to the DB2-established stored procedures address space, you can have several WLM established address spaces. For DB2-established or WLM-established address spaces you can specify a number of task control blocks (TCBs) in this address space available for stored procedures. Each stored procedure is executed under one TCB. After searching the SYSIBM.SYSPROCEDURES table, DB2 searches for an available TCB to be used by the stored procedure and notifies the stored procedure address space to execute the stored procedure.

5. When DB2 notifies the stored procedures address space to execute a stored procedure, the thread that was created for the client application is reused for an execution. This has the following implications:
   - CPU cost is low because DB2 does not create a new thread.
   - Accounting is on behalf of the client application.
   - For static SQL, the OWNER of the client program must have execute privilege on the stored procedure package. For dynamic SQL issued by the stored procedure, security is checked against the user of the client program, unless the DYNAMICRULES(BIND) option was specified when binding the package for the stored procedure. No sign-on or connection processing is required.
   - Any processing done by the stored procedure is considered a logical continuation of the client application's unit of work. Thus, locks acquired by the stored procedure are released when the client application commits or rolls back.

---

10. Why is the SQLCA inside SP not propagated on the Call statement?

Q. My stored procedure gets SQLCODE of 0, but it doesn't look like the SQL executed. How can I tell what's happening?
A. When the SQL CALL statement to execute a stored procedure gets SQLCODE=0, this means that the stored procedure program was loaded and executed successfully with no abnormal terminations. SQLCODES from SQL issued inside of the stored procedure program are not propagated to the call statement. The exception to this is that if SQL statements are issued that are not allowed from a stored procedure (COMMIT, ROLLBACK, CONNECT, etc.) cause a -571 SQLCODE to be returned on the CALL statement. Your stored procedure program needs to process errors by checking the SQLCODE and either setting an output parameter, or issuing an SQL ROLLBACK statement.

---

11. Do I have to run my WLM stored procedures with APF-authorization and LLA?

No. The confusion comes in mostly when the DB2 load libraries are not in the STEPLIB concatenation because they are being loaded from LINKLIST. In this case, if you want the stored procedure program to run APF-authorized, then linkedit it with AC=1 into an MVS APF authorized library. If you do not want the stored procedure program to run APF authorized, then the DB2 load library should be added to the STEPLIB concatenation of the JCL used to start the WLM-managed address space

---

12. How do I set up WLMENV with RACF in V6?

Q. In V5, there was control over which users could insert rows to SYSIBM.SYSPROCEDURES. In V6, any user can CREATE PROCEDURE in their schema. How can this be controllled?

A. In V6, DB2 does a RACF authorization check on the WLMENV during CREATE PROCEDURE and ALTER PROCEDURE. To protect a particular WLM application environment name, use RDEFINE for resource class DSNR, and then do RACF PERMIT calls to allow users to access them. RACF wildcard rules using '*' can be used for multiple environments. DB2-established stored procedures, which are created with the NO WLM ENVIRONMENT option of CREATE PROCEDURE, are

protected using the DB2 stored procedures address space name in place of the WLM Environment name on the RDEFINE and PERMIT calls.

In a datasharing environment , the datasharing groupname is used instead of the subsystem name.

Examples: To prevent all users on DB2 | subsystem DB2A (non-data sharing) from creating a stored procedure or user-defined function in the WLM environment named PAYROLL:

RDEFINE DSNR (DB2A.WLMENV.PAYROLL) UACC(NONE)

to authorize a DB2 user (DB2USER1) to create stored procedures on DB2 subsystem DB2A (non-data sharing) in the WLM environment named PAYROLL:

PERMIT DB2A.WLMENV.PAYROLL CLASS(DSNR) ID(DB2USER1) ACCESS(READ)

---

13. When using WLM SPs and RRS, what setup on the OS/390 system is required?

Q. I read that you have to configure RRS in order to use WLM-managed stored procedures. What does this entail?
A. To configure RRS, there are 4 mandatory RRS logstreams that need to be defined, and one optional one. These can either be defined in a Coupling Facility or as DASD-only (available in OS/390 V2.4 and higher). If you are only using RRS because you want to run WLM-managed stored procedures, and aren't using RRS to coordinate with any other S/390 resource managers, then you can make these log stream data sets very small. DB2 and RRS know to use an optimized path with minimal overhead in this environment.

---

14. When writing debug statements, how do I use the ENQ option to avoid 02A abends?

Q. I'm trying to debug my stored procedures and have print statements in it, but when I run more than one task in the stored procedures address space, I see 02A abends.

A. LE/370 has added support to serialize writes to the JES2 queue in order to solve this. Apply LE APAR PQ14532 and change runopts in SYSPROCEDURES or CREATE PROCEDURE to include the string 'MSGFILE(SYSOUT,FBA,121,0, ENQ)'.

---

15. Where are the -471 reason codes in V6 books ?

The messages and codes book for V6 is being re-issued to fix this. In V6, several of the reason codes for the -471 have been eliminated, because their error conditions are detected at CREATE PROCEDURE time, instead of when the SQL CALL statement is processed.

Reason codes that can be returned on the -471 in V6
00E79001, 00E79002, 00E79004, 00E79006, 00E79007, 00E79008, 00E7900B, 00E7900C, 00E7900E

00E7900E : SQL CALL statement or user-defined function invocation could not be processed. The routine was invoked by another stored procedure or user-defined function which had the opposite characteristic of being WLM-managed or DB2-managed from this routine. Nesting is not allowed between DB2-managed stored procedures and WLM-managed stored procedures or user-defined functions.

System Action: The SQL statement is rejected with SQLCODE -471 and this reason code.

Programmer Response: Use the -ALTER PROCEDURE command to change the value to NO WLM ENVIRONMENT, or alter the invoking routine to not invoke this one.

Stored Procedures FAQS

16**. How is ASUTIME handled?**

ASUTIME is designed to be used for runaway stored procedures applications, not as a tight control on how much CPU time a stored procedure can use. The routine to check for overages on ASUTIME only runs once per minute of clock time, so DB2 is unlikely to catch a stored procedure that exceeds a few seconds of CPU time. WLM priorities and service goals should be used to tightly control system resource usage instead of ASUTIME.

---

17. How do I create of Stored procedures and the factors that will affect them ?

Here is the **Sample DDL of a stored procedure**

```
CREATE PROCEDURE  LPRADU1.LPRSP002
       ( OUT    IN010                  INTEGER
        )
       RESULT SETS           1
       EXTERNAL NAME 'LPRSP002'
       LANGUAGE              COBOL
       PARAMETER STYLE       DB2SQL
       NOT DETERMINISTIC
       FENCED
       MODIFIES SQL DATA
       NO DBINFO
       COLLID                LPROBJU1
       WLM ENVIRONMENT       DBDDENVU
       ASUTIME NO LIMIT
       STAY RESIDENT YES
       PROGRAM TYPE MAIN
       SECURITY              DB2
       COMMIT ON RETURN NO
       ;
```

- External name is the name of the load module loaded from the STEPLIB of the WLM startup proc

- Language is the language of the stored procedure
  ASSEMBLE, C, COBOL, PLI, COMPJAVA, JAVA, REXX (WLM-managed required)

- ASUTIME NO LIMIT|LIMIT integer
  Maximum number of CPU service units that one invocation can consume

- PROGRAM TYPE SUB|MAIN

  MAIN:
  higher CPU cost for call/cleanup but full language capability and guarantee resources are freed
  Only WLM managed can use this option

  SUB:
  less CPU cost for call/cleanup
  program must be dynamically loadable
  application must free resources (storage, files)

- Creator must have the CREATEIN authority in the schema (LPRADU1 in this case)

- EXECUTE authority to the OWNER of execution of the calling program

- Static versions use BIND PATH option, call will look like
  CALL LPRADU1.LPRSP002(:HV1
  CALL LPRADU1.LPRSP002 USING DESCRIPTOR :sqlda

- Dynamic versions use CURRENT PATH special register before calling STORED PROCEDUREs
  CALL :variable(:HV1)

Stored Procedures FAQS

- Stored procedures can use DDL, DCL, DML in static and dynamic forms
- SET CURRENT SQLID only with **DYNAMICRULES RUN BIND** option
- ALTER PROCEDURE can not change parameters
- A stored procedure, user-defined function, or trigger cannot call a stored procedure that is defined with the COMMIT ON RETURN clause.
