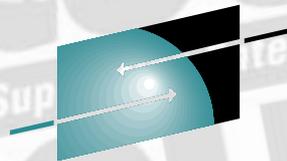# Resource Affinity Scheduling in OS/390 R4

BY R.P. SHANNON

Resource Affinity Scheduling was introduced in OS/390 R4. It provides the ability to ensure that a job will execute on a system that has all the resources the job requires.

THROUGH the introduction of Parallel Sysplex and the Workload Manager (WLM), IBM has invested heavily to improve transaction processing. Stogy, unglamorous batch processing was largely ignored until OS/390 R4 when WLM Managed Initiators and Resource Affinity Scheduling were introduced. Resource Affinity Scheduling provides a mechanism to direct batch jobs to specific systems based on the availability of resources. This article will examine Resource Affinity Scheduling and provide some tips on how to implement it in your shop.

WHY NOT RUN BATCH EVERYWHERE?

The most common reasons for directing batch work to specific systems are that some resources are not available on every system, or that it was decided batch work should simply not run on a system during a particular time or perhaps not at all. The latter is often indicative of a system dedicated to online processing.

One of the tenets of a Parallel Sysplex is to configure systems symmetrically so that all hardware and software resources are available to all systems in the Sysplex. Why then would anyone choose to not configure symmetrically? There are few good reasons. Some devices, particularly older ones that attach with parallel channels, can only be attached to a fixed number of systems. The non-ESCON 3995 Optical Storage and "Round Tape" (3420) are examples. Other special purpose hardware such cryptographic or vector processors may only be installed on selected systems.

Software, too, can be tricky. OS/390, with its 70 or so elements, will be installed on every system in a Sysplex, but shops may choose to not activate every element on every system. Although Parallel Sysplex Licensing Charges (PSLC) are the norm, there are some products that will only be licensed for a limited number of systems: compilers, 4GL report writers, utility programs, repositories such as MXG, and data base managers that are out of fashion to name a few. Add to the list a hodgepodge of products acquired through acquisitions and mergers, products that may not have the same favorable license agreements that you usually negotiate, and symmetry goes out the window. Small shops may limit licensing for budgetary reasons. Large shops may decide that symmetry alone cannot justify the expense of licensing software on dozens of systems.

DIRECTING ACCESS TO RESOURCES

Routing work to resources is not a new concept. Over the years many elaborate job class and initiator schemes have been established to ensure batch jobs execute on the correct system. These schemes tend not to be very granular, and often initiators must support multiple job classes, which can introduce additional problems.

System Affinity, a JES2 construct, can be employed to identify the systems on which a job is eligible to execute. System Affinity is requested by coding a SYSAFF parameter on the /*JOBPARM statement. The default system is ANY, which makes every system in the Multi-access Spool (MAS) eligible. JES3 provides similar capability on the //*MAIN card. The drawback to SYSAFF or //*MAIN is that the user's JCL must be changed to either add additional systems or to remove systems from eligibility.

A NEW APPROACH

Resource Affinity Scheduling offers an alternative to prior schemes. Implementation requires four steps:

◆ identify resources
◆ associate resources with scheduling environments
◆ identify the systems on which the resources are available
◆ request a scheduling environment through JCL

The advantages are granularity and flexibility. Up to 999 scheduling environments can be created; however, I recommend restraint. JES2 support for the SCHENV statement was introduced in OS/390 R4. JES3 support is not available in R5 but should be forthcoming. SCHENV is ignored by APPC-initiated jobs, and if coded will cause a started task to fail. If SYSAFF is coded in conjunction with SCHENV, the eligible systems will be limited to those identified on the SYSAFF statement.

Resource Affinity Scheduling requires all systems sharing a JES2 multi-access spool (MAS) to be at JES2 OS/390 2.4 or higher. Additionally, either a $ACTIVATE must be issued or a cold start performed. One must minimally run in WLM compatibility mode. This means the IPS/ICS can be used instead of Goal Mode, but a WLM couple dataset must be allocated and a WLM policy must be active.

Do not issue $ACTIVATE until you have read WSC Flash WF9817A - "JES2 $ACTIVATE Warning for OS/390 Release 4 and 5," as problems have been encountered in some shops.

RESOURCES

A resource identifies something that is necessary for job execution. It can be hardware such as a vector processor, a product such as ADABAS, a construct such as a particular test database, or something abstract such as shift. A resource must be given a name. Using descriptive resource names such as PL1_Compiler is recommended, but from a purely technical standpoint a name such as XXX will work just as well.

Resources can be in three states: ON, OFF, and RESET. ON indicates a resource is available; OFF indicates it is unavailable; and RESET indicates the state has not been set.

SCHEDULING ENVIRONMENT

A scheduling environment is comprised of a set of resources. An environment may be comprised of a single resource, such as a COBOL Compiler or a group of resources such as SAS, a database, and a 3995 Optical Disk. Users request a scheduling environment by coding the SCHENV parameter on the jobcard. Users cannot directly request resources; they can only request a scheduling environment. If a nonexistent or invalid scheduling environment is requested, the job will fail with a JCL error. If the scheduling environment name contains an underscore (_), the name must be in quotes. For example:

```
SCHENV='3420_TAPE'.
```

GETTING STARTED

Resource Affinity Scheduling requires a Basic or Parallel Sysplex. Resource Affinity Scheduling is correctly advertised as available in WLM Compatibility Mode. However, what may not be obvious is that the scheduling environment is implemented as part of a WLM Service Definition. This requires a policy, workload, and service class to be defined even if you intend to run in Compatibility Mode. Scheduling environments are defined using the Workload Manager ISPF Dialog. The steps to create a scheduling environment include:

1. define the WLM Couple Datasets
2. create a service definition that includes the scheduling environment
3. install the service definition
4. activate the policy
5. modify WLM to define resource states

WLM Couple Datasets created prior to OS/390 R3 may not be large enough due to the addition of some new items. Use the IXCL1DSU utility to create new WLM Couple Datasets. A new item name, SCHENV, should be coded to ensure space for the scheduling environments.

USING THE DIALOG

The WLM ISPF Dialog is used to create the scheduling environment. Select Option 3 "Create New Definition" to begin (Figure 1). Select Option 10 to create a scheduling environment (Figure 2). You are given the option to define scheduling environments first or resources first. We elected to define a scheduling environment (Figure 3) as the

dialog will lead into the Resource Definition Panel. A scheduling environment can be up to 16 alphanumeric characters, including national characters $, #, or &, and can also contain imbedded underscores. An underscore cannot be the first or last character. We defined a scheduling environment called OSVS_COBOL (Figure 4).

Under "Action" we entered an "a" (add) to define resources. In the Resource Definition we also entered an "a" under Action to define a resource (Figure 5). The resource we defined is OSVS_COBOL, the same name as the scheduling environment (Figure 6). A scheduling environment can have the same name as one of its resources or a different name. In this case, we think the name of the environment will make it easy for the users to remember and request. After defining Resource OSVS_COBOL we selected it for the OSVS_COBOL scheduling environment (Figure 7).

We also defined and selected a resource named PROD_ONLINE (not shown). Whenever production online work is running, the PROD_ONLINE Resource state will be ON. On the test system the normal state will be OFF.

We returned to the Scheduling Environment panel and indicated the required state of the OSVS_COBOL Resource is ON and the required state of PROD_ONLINE is OFF (Figure 8). Jobs requesting the OSVS_COBOL scheduling environment will not execute on systems where online work is running. Exiting the panel caused the scheduling environment to be created (Figure 9).

We repeated this exercise several times until we created four scheduling environments (Figure 10) and 10 resources (Figure 11). Figure 12 shows the resources and their required state for each scheduling environment.

Before we could install our definition we had to define a WLM policy, workload, resource group, and service class. Since we have no immediate plans to run in Goal Mode, we defined these items with minimal information. Our policy is called SHARE. The Workload name is DUMMY as is the Resource Group name. We defined one service class with an average response time of one hour. **Do not switch to Goal Mode using this policy!** We installed our definition by tabbing to the Utilities Option on the primary WLM panel and selecting option 1 "Install definition". The last step was to activate the service policy using Option 3 of the Utility pop-up "Activate service

policy". WLM modify commands were subsequently issued to make the scheduling environments available.

IDENTIFYING THE STATE OF RESOURCES

The WLM does not dispatch agents to locate resources. Rather, it must be explicitly told which resources are available on which systems. Clearly the state of hardware resources such as cryptographic processors could be identified by automatically querying the systems; however, this capability currently does not exist. Instead, the state of resources is identified by issuing a Modify Command:

```
F WLM,RESOURCE=resource_name,ON|OFF|RESET
```

When a policy is activated its resources have a state of RESET. Scheduling environments that require any of the resources will have a status of 'NOT AVAILABLE'. A scheduling environment will automatically become 'AVAILABLE' when all of its resources are in the required state (ON or OFF). Sample modify commands are shown in Figure 13.

When the WLM is ready to accept modify commands, it issues message "IWM041I WORKLOAD MANAGE-MENT ADDRESS SPACE MODIFY COMMAND AVAILABLE". During IPL, COMMNDxx is processed long before the WLM will accept modify commands, so the modify commands cannot be issued from COMMNDxx. You can use an automation product to issue the commands, triggered by message IWM041I.

The difficulty in automating the modify commands is in predefining the state of resources. Most automation products can read a file and issue commands based on file contents. For each system in a Sysplex there will have to be such a file that reflects the correct state of the resources. The file will have to be kept updated to reflect the current resources. When a new policy is activated at a time other than during WLM startup, the WLM issues message "IWM001I WORKLOAD MANGEMENT POLICY XXXXXXXX NOW IN EFFECT'. If the file is updated before activating the new policy, automation will be able to set the resource state. Otherwise, the modify commands will have to be entered manually.

COMMUNICATING SCHEDULING ENVIRONMENTS

Scheduling environments and their associated resources must be communicated

---

Figure 1: Choose Service Definition Panel

```
File  Help
------------------------------------

Command ===> _____

                  Choose Service Definition

           Select one of the following options.
        3    1. Read saved definition
             2. Extract definition from WLM
                couple data set
             3. Create new definition



          ENTER to continue
```

Figure 2: WLM Definition Menu

```
File   Utilities  Notes  Options  Help
        -------------------------------------------------------
Functionality LEVEL001          Definition Menu          WLM Appl LEVEL004
Command ===>
_____

Definition data set  . . : none

Definition name  . . . . . _____   (Required)
Description . . . . . . . _____

Select one of the
following options. . . . . 10_     1.  Policies
                                   2.  Workloads
                                   3.  Resource Groups
                                   4.  Service Classes
                                   5.  Classification Groups
                                   6.  Classification Rules
                                   7.  Report Classes
                                   8.  Service Coefficients/Options
                                   9.  Application Environments
                                  10.  Scheduling Environments
```

Figure 3: Define a Scheduling Environment or Resource(s)

```
                         Decide what to create?
Command ===>
_____

No scheduling environments exist. Would you like to create a scheduling
environment or define resources for scheduling environments?

Select one of the following options.
1_  1.  Create Scheduling Environment
    2.  Create Resource(s)
```

Figure 4: Create a Scheduling Environment

```
  Scheduling-Environments  Notes  Options  Help
------------------------------------------------------
                  Create a Scheduling Environment  Row 1 to 1 of 1
Command ===>
_____

Scheduling Environment Name    OSVS_COBOL          Required
Description . . . . . . . . . OSVS COBOL Compiler

Action Codes: A=Add  D=Delete

                         Required
Action  Resource Name      State      Resource Description
  a_                       _____
```

to the user community. A company standards manual is the ideal place to describe these environments. Another possibility is a JESNEWS-like facility that lists the environments when requested. A third possibility is to allow users to display the scheduling environments through SDSF. Bear in mind that a scheduling environment becomes fairly permanent once users change their JCL to request it.

ERROR MESSAGES

WLM error messages are documented in "OS/390 MVS Programming: Workload Management Services" not in "Messages and Codes." The messages are unfriendly to the point of hostility. While attempting to install a definition we received the following dialog message:

Install failed, service definition is not valid. Validation reason code: 3D25, Validation offset: 1068. (IWMAM044)

Seeking clarification, we read the explanation for message IWMAM044 and found that reason 3D25 indicates that "In the scheduling environment to resource connection, the scheduling environment name (SVSEA_SR_SCHENV_NAME) is not in the list of defined scheduling environments." Still clueless as to what was wrong, we ran the IEHIBALL utility several times seeking obvious errors. This too proved futile so we trashed everything and started over. Suffice it to say the error messages and online help need work.

SDSF

SDSF 1.8 provides support for Resource Affinity Scheduling. Figure 14 displays the status of the scheduling environments and shows state of resources. Since this snapshot was taken as resource states were being set, only the 3420_TAPE scheduling environment is available to System P390.

NEXT STEPS

Resource Affinity Scheduling has potential, but some shortcomings need to be addressed:

1. The requirement to identify systems with resources through operator commands is unacceptable. Since the state of resources must be known in advance in order to automate the modify commands, it makes sense to define the state for each system in the Sysplex on the Resource Definition Panel.

Figure 5: Add a Resource to a Scheduling Environment

```
  Resources  Notes  Options  XREF  Help
----------------------------------------------------------
                           Resource Definition List     Row 1 to 1 of 1
Command ===>
_____

Selection For Scheduling Environment OSVS_COBOL

Action Codes: A=Add  S=Select  X=XREF  /=Menu Bar

Action   Resource Name     In Use  Resource Description
  _a_                              _____
```

Figure 6: Define a Resource

```
                         Define Resource
Command ===> _____

Resource name  . . . . . . . .  OSVS_COBOL_____   Required
Resource Description . . . . .  Antique COBOL Compiler
```

Figure 7: Select a Resource to be Added to the Scheduling Environment

```
  Resources  Notes  Options  XREF  Help
----------------------------------------------------------
                           Resource Definition List     Row 1 to 1 of 1
Command ===>
_____

Action Codes: A=Add  D=Delete  X=XREF  /=Menu Bar

Action   Resource Name     In Use  Resource Description
  _S_    OSVS_COBOL                Antique COBOL Compiler
```

Figure 8: Indicate the Required State of a Resource

```
Scheduling-Environments  Notes  Options  Help
----------------------------------------------------------
Command ===>
_____

Scheduling Environment Name    OSVS_COBOL         Required
Description  . . . . . . . . . _____

Action Codes: A=Add   D=Delete   State for a resource must be specified.
                                  Specify either ON or OFF. (IWMAM676)

Action   Resource Name     State      Resource Description
  __     OSVS_COBOL        ON_____
  __     PROD_ONLINE       OFF____
```

Figure 9: Scheduling Environment List After Creating OSVS_COBOL

```
  Scheduling-Environments  Notes  Options  Resources  Help
----------------------------------------------------------
             Scheduling Environment Selection ListRow   1 to 1 of 1
Command ===>
_____

Action Codes: 1=Create, 2=Copy, 3=Modify, 4=Browse, 5=Print, 6=Delete,
              /=Menu Bar

Action  Scheduling Environment Name  Description
  __     OSVS_COBOL



         Scheduling environment OSVS_COBOL was created. (IWMAM654
```

2. Scheduling scope is limited to a single Sysplex. Since most shops will have multiple Sysplexes, a scheduling environment should identify the Sysplex to which it pertains so that if a scheduling environment is moved to another Sysplex the requesting job will automatically be routed.

3. An improved help facility with improved error diagnoses is required.

MAINTENANCE

Review info APAR II10760 "JES2 Maintenance for OS/390 R4." We recommend PTFs be applied for the following APARs:

```
OW26619  PER FINAL FUNCTION TEST
         CORRECTIONS FOR WLM AND SRM
         COMPONENTS IN OS/390 R4
OW30336  PER WLM INITIATOR NOT STARTED FOR
         JOB THAT USES SYSAFF OR SCHENV
OW28859  PER SDSF JOB INFO POPUP DOES
         NOT DISPLAY SYSTEMS WHERE SCHENV
         IS AVAILABLE
```

RACF SUPPORT

RACF APAR OW25727 (closed 97/05/19) provides the ability to restrict execution of a particular resource to a specific system or systems. Although this APAR is not required for Resource Affinity Scheduling, it can guarantee that products are only used on the systems for which they are licensed.

```
PERMIT program_name CLASS(PROGRAM)
  ID(id) ACCESS(READ)
WHEN(SYSID(system_name))
```

CONCLUSION

Despite some shortcomings, Resource Affinity Scheduling is a welcome addition to OS/390. A number of shops that modified JES2 to achieve similar functionality can remove their modifications. Shops without these modifications now have functionality that was previously lacking. Historically, IBM products have improved significantly in response to user requirements. We expect the same for Resource Affinity Scheduling.

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OS/390 MVS System Commands; GC28-1781-03; IBM Corporation

Figure 10: Scheduling Environment List After Multiple Environments Were Created

```
  Scheduling-Environments  Notes  Options  Resources  Help
--------------------------------------------------------------
             Scheduling Environment Selection ListRow      1 to 4 of 4
Command ===>
_____

Action Codes: 1=Create, 2=Copy, 3=Modify, 4=Browse, 5=Print, 6=Delete,
              /=Menu Bar

Action   Scheduling Environment Name   Description
  __        DEVELOPMENT                 Standard Development Env
  __        FIN_PROD                    Financial Production Env
  __        3420_TAPE                   Round Tape
  __        OSVS_COBOL                  Antique COBOL Compiler
```

Figure 11: Resource Definition List With Multiple Resources Defined

```
  Resources  Notes  Options  XREF  Help
--------------------------------------------------------------
                        Resource Definition List    Row 1 to 10 of 10
Command ===>
_____

Action Codes: A=Add   D=Delete   X=XREF   /=Menu Bar

Action    Resource Name       In Use    Resource Description
  __        DB2_V4             YES       DB2 Version 4
  __        DB2_V5             YES       DB2 Version 5
  __        FIN_PROD_DB        YES       Financial Division Prod DB
  __        FIN_TEST_DB        YES       Financial Division Test Database
  __        OPTICAL            YES       3995 Optical Storage
  __        OSVS_COBOL         YES       Antique COBOL Compiler
  __        OS390_COBOL        YES       Current COBOL Compiler
  __        PROD_ONLINE        YES       Production Online Processing
  __        ROUND_TAPE         YES       3420 Tape Drives
  __        SAS                YES       Statistical Analysis System
```

Figure 12: Required Resource States

```
Scheduling Environment Name. . DEVELOPMENT
 Description. . . . . . . . . . Standard Development Env

  Resource Name     State    Resource Description
  ---------------------------------
  DB2_V5            ON       DB2 Version 5
  FIN_TEST_DB       ON       Financial Division Test Database
  OS390_COBOL       ON       Current COBOL Compiler
  PROD_ONLINE       OFF      Production Online Processing
  SAS               ON       Statistical Analysis System

Scheduling Environment Name. . FIN_PROD
Description. . . . . . . . . . Financial Production Env

  Resource Name     State    Resource Description
  ---------------------------------
  DB2_V4            ON       DB2 Version 4
  FIN_PROD_DB       ON       Financial Division Prod DB
  OPTICAL           ON       3995 Optical Storage

Scheduling Environment Name. . 3420_TAPE
Description. . . . . . . . . . 3420 Tape

  Resource Name     State    Resource Description
  ---------------------------------
  ROUND_TAPE        ON       3420 Tape Drives

Scheduling Environment Name. . OSVS_COBOL
Description. . . . . . . . . . Antique COBOL Compiler

  Resource Name     State    Resource Description
  ---------------------------------
  OSVS_COBOL        ON       Antique COBOL Compiler
  PROD_ONLINE       OFF      Production Online Processing
```

Figure 13: Sample Modify Commands to Set Resource State

```
f wlm,resource=3420tape,on
IWM039I RESOURCE 3420TAPE IS NOW IN THE ON STATE
f wlm,resource=PROD_ONLINE,ON
IWM039I RESOURCE PROD_ONLINE IS NOW IN THE ON STATE
F WLM,resource=optical,on
IWM039I RESOURCE OPTICAL IS NOW IN THE ON STATE
f wlm,resource=osvs_cobol,on
IWM039I RESOURCE OSVS_COBOL IS NOW IN THE ON STATE
f wlm,resource=os390_cobol,on
IWM039I RESOURCE OS390_COBOL IS NOW IN THE ON STATE
f wlm,resource=fin_test_db,on
IWM039I RESOURCE FIN_TEST_DB IS NOW IN THE ON STATE
```

Figure 14: SDSF Scheduling Environment Display

```
 Display  Filter  View  Print  Options  Help
–––––––––––––––––––––––––––––––––––––––––––––––––––––––––
SDSF SCHEDULING ENVIRONMENT DISPLAY MAS SYSTEMS     LINE 1-4 (4)
COMMAND INPUT ===>                                  SCROLL ===> PAGE
PREFIX=RPS*  DEST=(ALL)  OWNER=*
NP    SCHEDULING-ENV      DESCRIPTION                 SYSTEMS
      DEVELOPMENT         Standard Development Env
      FIN_PROD            Financial Production Env
      3420_TAPE           3420 Tape                    P390
      OSVS_COBOL          Antique COBOL Compiler

SDSF RESOURCE DISPLAY MAS SYSTEMS
COMMAND INPUT ===>
PREFIX=RPS*  DEST=(ALL)  OWNER=*
NP    RESOURCE            P390
      DB2_V4              RESET
      DB2_V5              RESET
      FIN_PROD_DB         RESET
      FIN_TEST_DB         ON
      OPTICAL             ON
      OSVS_COBOL          ON
      OS390_COBOL         ON
      PROD_ONLINE         ON
      ROUND_TAPE          ON
      SAS                 RESET
```

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SDSF Guide and Reference; SC28-1622-02; IBM Corporation

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* Available at www.s390.ibm.com/wlm/documents/

Opinions stated in this article are the author's and do not necessarily reflect those of Programart.

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