z/OS 3.1 IBM Education Assistant

Solution Name: JES2 Resource Limits

Solution Element(s): JES2

July 2023

Agenda

- Trademarks
- Objectives
- Overview
- Usage & Invocation
- Interactions & Dependencies
- Upgrade & Coexistence Considerations
- Installation & Configuration
- Summary
- Appendix

Trademarks

- See URL http://www.ibm.com/legal/copytrade.shtml for a list of trademarks.
- Additional Trademarks:
  - None

Objectives

- In this presentation we will introduce enhancements to JES2 resource management interfaces implemented in JES2 3.1
- These enhancements include two separate but related functions:
  - Ability to limit consumption of JES2 resources by individual jobs in order to avoid critical resource shortage that can impact entire JES2 installation
  - Ability to monitor consumption of JES2 resources by groups of related jobs.
    In a future release, this function will be extended to allow limiting consumption of JES2 resources at the group level.

Overview

- Who (Audience)
  - JES2 system administrators managing JES2 resources
- What (Solution)
  - Allow to define and enforce a limit on consumption of JES2 resources by individual jobs
  - Allow to define job resource groups, to assign jobs to the resource groups and to keep track of consumption of JES2 resources at the resource group level.
- Wow (Benefit / Value, Need Addressed)
  - Prevent run-away jobs from depleting JES2 resources
  - Protection for selected JES2 resources is available “out of the box” – immediately after JES2 3.1 is installed
  - Allow more flexible management of JES2 resources

Overview – job resource limit

- The worst nightmare of a JES2 administrator is a run-away job that keeps consuming some JES2 resource in a loop and causes critical shortage of that resource.
  In the worst case, entire system grinds to a halt and requires emergency manual intervention to recover.
- In 3.1, JES2 allows to specify a limit of resource consumption by a single job and to define an action taken when job exceeds this limit
- The following JES2 resource types are supported in 3.1:
  - JES2 SPOOL space – resource type TG (Track Group)
  - JES2 output groups – resource type JOE (Job Output Element)

Overview – job resource limit (2)

- The limit is specified as a percentage of a total amount of resource available to the JES2 installation
- There are three actions that JES2 can take when job exceeds specified limit:
  - ACTION=NONE - JES2 will issue a message but will not prevent the job from consuming more resources
  - ACTION=WAIT – JES2 will issue a message and will suspend allocation of affected resource to offending job until more resources become available to the job
  - ACTION=FAIL – JES2 will issue a message, and request for resource allocation will fail. Depending on the state of the job and the type of resource request, this may cause the job to fail or may cause affected JES2 function to fail.
- The resource limits and the related action can be configured at the job class level or can be managed at the individual job level using JES2 policies

Overview – job resource limit (3)

- If job resource limit settings are not explicitly configured, JES2 will apply system defaults:
  - The default limit depends on the size of installation:
    - For a “small” installation, limit is 75%
    - For a “large” installation, limit is 25%
    - The meaning of “small and “large” environments is the same as for privileged job support introduced in JES2 2.3. Environment is “small” when it has fewer than 10000 track groups in JES2 SPOOL or fewer than 600 JOEs.
  - The default action is WAIT.
- Note that as soon as JES2 member is upgraded to 3.1 level, these system defaults will take effect immediately on that member

Overview – job resource groups

- In 3.1, JES2 allows to configure job resource groups to monitor resource usage by the groups of related jobs, and to assign individual job to a resource group
- JES2 will aggregate usage of JES2 resources at the resource group level and will provide interfaces to report these counters
- The following JES2 resource types are supported in 3.1:
  - JES2 SPOOL space – resource type TG (Track Group)
  - JES2 output groups – resource type JOE (Job Output Element)
  - JES2 job control structures - resource type JQE (Job Queue Element)
  - JES2 BERTs (Block Extension Reuse Tables) – resource type BERT.
    (BERTs is an important JES2 resource. JES2 uses BERTs to store various operational data about jobs and output groups.)

Overview – job resource groups (2)

- In 3.1, JES2 job resource groups are only used for reporting purposes
- In a future release, JES2 will provide resource limit enforcement at the resource group level similar to one provided at the single job level

Usage & Invocation – job resource limits

- Job resource limits can be configured at the job class level
- New keywords are provided on the JOBCLASS initialization statement and JOBCLASS commands to define limit and related action:

```
$T JOBCLASS(x),RESOURCE( TG   ) = (LIMIT =   n        ,ACTION = NONE     )
                         JOE                DEFAULT             WAIT
                                                                FAIL
                                                                DEFAULT
```

- Here “x” is a job class name, “n” is resource usage limit as percentage of total available (1% - 100%)
- Valid values for RESOURCE keyword:
  - **TG** - JES2 SPOOL space (Track Group)
  - **JOE** - JES2 output groups (Job Output Element)

Usage & Invocation – job resource limits (2)

- Valid values for ACTION keyword:
  - **NONE** - JES2 will issue messages about offending job but will not prevent it from consuming more resources
  - **WAIT** – in addition to messages, JES2 will suspend allocation of affected resource to offending job until more resources become available to the job
  - **FAIL** – in addition to messages, request for resource allocation will fail.
  - **DEFAULT** – use system default (WAIT)
- DEFAULT value for LIMIT keyword is:
  - 75% for “small” environment
  - 25% for “large” environment
  - The meaning of “small and “large” environments is the same as for privileged job support introduced in JES2 2.3
    Environment is “small” when it has fewer than 10000 track groups in JES2 SPOOL or fewer than 600 JOEs.

Usage & Invocation – job resource limits (3)

- Example of a job class command:

```
$t jobclass(x),res(tg)=(limit=1,action=fail)

$d jobclass(x),res
$HASP837 JOBCLASS(X)
JOBCLASS(X)          RESOURCE(TG)=(LIMIT=1,ACTION=FAIL),
                     RESOURCE(JOE)=(LIMIT=DEFAULT,
                     ACTION=DEFAULT)
```

- This example sets SPOOL resource limit (resource type TG) for jobs in job class X to 1% and sets related action to FAIL, leaving settings for output groups (resource type JOE) at default values.

Usage & Invocation – job resource limits (4)

- Job resource limits can also be examined and set for individual jobs via a set of job attributes available for use in JES2 policies of types JobCreate, JobInput, PreConversion and JobConversion:
  - TGResLimit and TGResAction - to control resource type TG
  - JOEResLimit and JOEResAction - to control resource type JOE
- Syntax and semantics of these attributes is similar to respective keywords in job class commands, except that value “DEFAULT” is not supported for xxxResLimit attributes – use 0 instead to reset values to system default.

Usage & Invocation – job resource limits (5)

- Example of JobInput policy:

```
{  "policyName":      " JB1",
   "policyVersion":   1,
   "policyType":      " JobInput ",
   "definitions":
      [
        {  "condition" : " substr(jobname,1,3) = 'MGC' ",
           "actions"  :
              [
                 {  "action"    : " ModifyJob ",
                    "attribute" : " TGResLimit ",
                    "value"     : " 5 "
                 },
                 {  "action"    : " ModifyJob",
                    "attribute" : " TGResAction",
                    "value"     : " ' WAIT '  "
                 }
              ]
        }
      ]
}
```

Usage & Invocation – job resource limits (6)

- This example sets SPOOL resource limit (resource type TG) for jobs with job names starting with “MGC” to 5% and sets related action to WAIT.
  Resource limit settings for output groups (resource type JOE) are not changed by this policy – they stay as determined by the job class of the job.

Usage notes – job resource limits

- With the job resource limit function in place, you will start seeing the following messages:

```
$HASP1807 Job XXX is approaching its RRR resource limit (RC=nn).
```

  - This message is issued when job consumes 90% of its configured limit
  - In this message, **XXX** is the job name, **RRR** is resource type (TG or JOE) and RC code indicates the code in JES2 that detects the condition.

```
$HASP1806 Job XXX exceeded its RRR resource limit.
ACTION=AAA (RC=nn).
```

  - This message is issued when job exceeds the configured limit
  - In this message, **XXX** is the job name, **RRR** is resource type (TG or JOE), RC code indicates the code in JES2 that detects the condition and **AAA** is the action taken by JES2

Usage notes – job resource limits (2)

- When ACTION=NONE, the message is the only action taken – job will not be prevented from consuming more of the resource.
- When ACTION=FAIL, the request for resource will fail. This may have different consequences depending on the type of the request and the state of the job. Some examples:
  - When job exceeds its TG or JOE limit, SYSOUT data set allocation will fail. This may or may not cause job to fail depending on how specific application reacts to the failure of data set allocation
  - When TG limit is exceeded when job is actively writing to a SYSOUT data set, JES2 will signal excession ABEND S722 RC=04.
  - For a job beyond execution phase, a specific JES2 action will fail.
    E.g., output group will not be created for the job. As a result, job and respective data sets will still be intact but will not be accessible through the interfaces that involve output groups. Some other interfaces (e.g., SPOOL browse) will have to be used to access the data.

Usage notes – job resource limits (3)

- When ACTION=WAIT, the result depends on the type of the request and the state of the job. Some examples:
  - If job is in execution phase (is actively executing), the job is suspended and JES2 waits for operator action
  - If job is beyond execution phase, the processing of the job is delayed until operator intervention
- In general, operator can do one of the following:
  - Purge some SPIN output owned by the job
  - Increase overall resource available to JES2 – e.g., add another SPOOL volume
  - Cancel or purge the job

Usage notes – job resource limits (4)

- In some stages of processing, JES2 cannot wait for operator intervention for technical reasons. In this case, ACTION=WAIT is promoted to ACTION=FAIL.
  - For example, if resource limit is exceeded when job is on NJE job receiver, job will be rejected and will have to be resent after the resource configuration is addressed.

Usage notes – job resource limits (5)

- Note that job resource limit settings can be changed via policies only at early stages in JES2 job processing. After job conversion phase, these setting can no longer be changed.
- Because of the goal to prevent adverse effect on performance of normal resource allocation code paths, resource limit detection may lag the consumption of resources. As a result, the enforcement of the limit is not precise. The job may be able to consume resources somewhat above the configured limit before JES2 code detects that and reacts to it.
- After a message about job resource limits was issued for a job, the message is not repeated unless resource consumption by the job changes or JES2 pool of a relevant resource changes
- However, code in different stages of job processing detects resource limits independently. As a result, it is possible to see HASP1807 and HASP1806 messages repeatedly for the same job as job progresses through different phases.

Usage & Invocation – job resource groups

- New RESGROUP initialization statement and new $ADD and $DEL RESGROUP commands are available to manage the JES2 resource groups
- At this time, resource groups have no attributes that can be configured.
- Use $D RESGROUP command to display the resources currently used by the jobs associated with the resource group

```
$d resgroup
$HASP1800 RESGROUP(X)
RESGROUP(X)           RESOURCE(TG)=(CURRENT=5,
                      PERCENT=0.4166),
                      RESOURCE(JQE)=(CURRENT=1,
                      PERCENT=0.2000),
                      RESOURCE(JOE)=(CURRENT=2,
                      PERCENT=0.2000),
                      RESOURCE(BERT)=(CURRENT=1,
                      PERCENT=0.1176)
```

Usage & Invocation – job resource groups (2)

- Resource group definition objects are stored in JES2 Checkpoint. RGDNUM keyword available on CKPTSPACE initialization statement and on $T CKPTSPACE command allows to manage the number of resource group entries reserved in JES2 Checkpoint.
  - The default number is 32 entries.
- Use RGD keyword on $D CKPTSPACE command to display the configured number of the resource group entries and number of unused (free) entries:

```
 $d ckptspace
 $HASP852 CKPTSPACE
CKPTSPACE  BERTNUM=850,BERTFREE=686,BERTWARN=80,
           CKPT1=(CAPACITY=1428,UNUSED=1008,
           TRACKS=120),CKPT2=(CAPACITY=1428,
           UNUSED=1008,TRACKS=120),CDI=(CDINUM=128,
           CDIFREE=128,CDTSIZE=524264,CDTFREE=524264),
           RGD=(RGDNUM=32,RGDFREE=31)
```

Usage & Invocation – job resource groups (3)

- New RESGROUP keyword was added to $D Jn command to display resource group association of a job

```
 $dj46
 $HASP890 JOB(RGX)
JOB(RGX)        STATUS=(AWAITING HARDCOPY),CLASS=A,
                PRIORITY=1,SYSAFF=(ANY),HOLD=(NONE),
                RESGROUP=X
```

- The RESGROUP keyword can also be used as a filter on various JES2 commands, related to job management – e.g., $T Jn command

Usage & Invocation – job resource groups (4)

- Assigning job to a resource group is achieved via a ResGroup job attribute available in JES2 policies of type JobCreate
- For example,

```
{  "policyName":      "JC1",
   "policyVersion":   1,
   "policyType":      " JobCreate ",
   "definitions":
      [ {  "condition" : " jobowner = 'DEPT5' ",
           "actions"  :
              [ {   "action"    : " ModifyJob ",
                    "attribute" : " ResGroup ",
                    "value"     : " 'RD5' "          } ]
        }
      ]
}
```

Usage & Invocation – SSIs

- JES2 SSIs have been enhanced to return data related to job resource limits and job resource groups:
  - SSI 82 (JES properties) - new resource group subfunction was added to return resource groups and their resource usage counts
  - SSI 82 (JES properties) – job class information subfunction was updated to return configured resource limits/action
  - SSI 80 (Extended Status) – new section was added to return resource usage/limits/action for the job
  - SSI 80 and SSI 85 (Extended Status and Job Modify) – new filter was added to select jobs based on the resource group name
  - Various SSIs (SAPI, Extended Status, Job Modify) – new fields were added to return resource group name of a job

Interactions & Dependencies

- Software Dependencies
  - None
- Hardware Dependencies
  - None
- Exploiters
  - JES2 administrators managing resources in JES2 MAS.
  - SDSF displays some of the new information on SDSF panels.
  - Note that the job resource limits function is enabled the moment JES2 3.1 is installed. If no explicit configuration changes are made, system defaults take effect.

Upgrade & Coexistence Considerations

- To exploit this solution, all systems in the Plex must be at the new z/OS level:
  - No
- Down-level members of JES2 MAS must have JES2 compatibility APAR OA61751 installed. Use the z/OS 3.1 coexistence SMP/E FIXCAT for the PTFs.

- Job resource limits function:
  - New job class keywords are not available on down-level MAS members
  - Policies that use related attributes cannot be imported on down-level members
  - Down-level members do not provide function that limits resource usage
  - However, jobs submitted on a down-level member will obtain their resource limit settings from job classes configured on a 3.1 member or from policies imported on a 3.1 member, so that these settings will take effect when job is processed by a 3.1 member.

Upgrade & Coexistence Considerations (2)

- Job resource group function:
  - Resource groups cannot be created on a down-level member
  - Jobs submitted on a down-level member cannot be assigned to a resource group
  - However, if job was submitted on a 3.1 member and assigned to a resource group, this job will be correctly represented in the resource group resource usage counters, even when this job is processed on a down-level member.

Upgrade & Coexistence Considerations (3)

- If you are not interested in the benefits of the resource limit function and you do not want the default resource limit processing to affect your normal workloads, it can be suppressed by this JES2 operator command:

```
$T JOBCLASS(*),RESOURCE(*)=(LIMIT=100,ACTION=NONE)
```

- This command will allow unlimited resource allocation for all new jobs entering JES2

Installation & Configuration

- Job resource limit function:
  - This function takes effect immediately when JES2 3.1 is installed.
  - Resource limits and actions associated with them can be configured at the job class level via job class attributes and at the individual job level via JES2 policies of types JobCreate, JobInput, PreConversion and JobConversion.

Installation & Configuration (2)

- Job resource group function:
  - Job resource group function requires some configuration
  - Job resource groups are configured via new RESGROUP command and initialization statement
  - Jobs are assigned to resource groups via JES2 policies of type JobCreate
  - Structures representing job resource groups are stored in JES2 Checkpoint and although they are relatively small, they do need some additional space in JES2 Checkpoint.
    JES2 will create necessary structures in JES2 Checkpoint as soon as it has adequate space in it. If these structures cannot be created, attempt to create resource group definition will fail with a relevant error message.
    If this happens, JES2 Checkpoint can be extended by $T CKPTDEF command, or RGDNUM keyword on $T CKPTSPACE command can be used to reduce the number of resource group entries to reserve in JES2 Checkpoint.

Summary

- In this presentation we discussed enhancements to JES2 resource management, that include two related functions:
  - Job resource limits
  - Job resource groups

Appendix

- Publications
  - z/OS V3R1.0 JES2 Commands
  - z/OS V3R1.0 JES2 Initialization and Tuning Guide
  - z/OS V3R1.0 JES2 Initialization and Tuning Reference
  - z/OS V3R1.0 JES2 Installation Exits
  - z/OS V3R1.0 JES2 Messages
  - z/OS V3R1.0 MVS Using the Subsystem Interface