z/OS V2.5 IBM Education Assistant

Solution Name: Predictive Failure Analysis (PFA) Exhaustion Check for Private Storage Exhaustion Above the 2 Gigabyte Bar

Solution Element(s): BCP PFA

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

- Discuss changes to the PFA_PRIVATE_STORAGE_EXHAUSTION Check
  - Shipped in V2R2 for below the 2G bar checking
    - Private user region - USER
    - Private authorized area - AUTH
    - Private below the line (private user + private authorized) - BELOW
    - Extended private user region - EUSER
    - Extended private authorized area - EAUTH
    - Private above the line (extended private user + extended private authorized) - ABOVE
  - Enhanced in V2R5 so that system operators can take action before a primary component fails or an outage occurs due to exhaustion above the 2G bar.
    - All above the 2G bar storage included – private, shared area, and low user private – ABV2G
    - Request for Enhancement (RFE) 250557

Overview

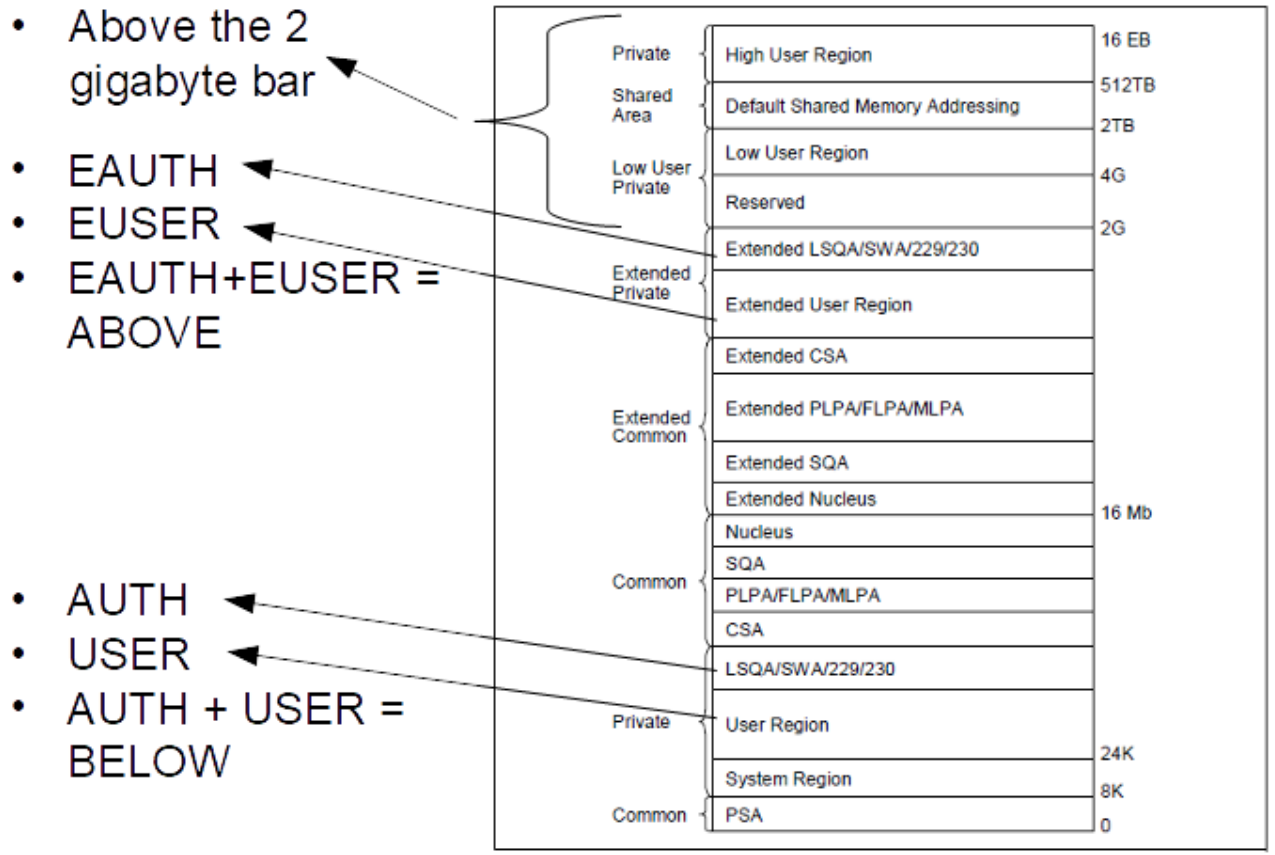
- Who (Audience)
  - Systems operators, systems programmers

- What (Solution)
  - Enhanced the PFA_PRIVATE_STORAGE_EXHAUSTION check to detect potential future private storage exhaustion above the bar as defined by the address space's MEMLIMIT.
  - If potential future exhaustion is detected based on the modeled trend of the current usage into the future for above the bar storage within an address space, PFA will issue an IBM Health Checker for z/OS exception.
  - When DEBUG(1) and exception occurs, PFA dumps both the PFA address space and the address spaces causing the exception.

- Wow (Benefit / Value, Need Addressed)
  - Assists in avoiding outages due to private storage exhaustion above the bar.

Usage & Invocation – slide 1 of 6

- Pictorial view of the storage tracked and predicted by the PFA_PRIVATE_STORAGE_EXHAUSTION check



- This check does not detect exhaustion due to fragmentation or fast increases of usage that are on a machine-time scale or faster than one collection interval.

Usage & Invocation – slide 2 of 6

- This check's report
  1. Shows dynamic exception severity and exception message at top of report
  2. Reminds you to look at new diagnostic actions in the "Operator Response" section of the message at the bottom of the report.
  3. Has new section headings
  4. Includes Runtime Diagnostics output for address spaces causing exception
  5. Shows rate of increase and time of start of increase for each storage location and for each address space listed for locations in exception
     - Values are when the model indicated a trend change.
     - Use this value in investigation to determine why and when the abnormal storage consumption occurred.
  6. Shows above the 2 gigabyte bar information in both sections 1 and 2
     - Storage above the 2 gigabyte bar is shown in megabtyes.
     - Numbers may have been given units by IBM Health Checker for z/OS, but still means that number of megabytes. For example, if a number is in megabytes and shows 10K, it means 10,240 megabytes (10,240,000,000 bytes)
     - Storage location for above the 2 gigabyte bar is abbreviated as ABV2G
  7. Lists recommended actions in the "Operator Response" of the exception message.
- Example on next page – A job was running that creeps storage usage above the 2 gigabyte bar.

Usage & Invocation – slide 3 of 6

1
2
3
6
5
3

```
* Medium Severity Exception Issued *

The private virtual storage usage for one or more address spaces has
been predicted to exceed the capacity by 10/05/2020 18:39:46.

See the 'Operator Response' section of the exception message below for
recommended actions.


             Private Storage Exhaustion Prediction Report

Last successful model time     :  10/05/2020 17:15:19
Next model time                :  10/06/2020 05:15:19
Model interval                 :  720
Last successful collection time:  10/05/2020 17:18:04
Next collection time           :  10/05/2020 17:23:04
Collection interval            :  5


SECTION 1: PRIVATE VIRTUAL STORAGE USAGE DATA

Address spaces causing exception above the 2 gigabyte bar:

                Current      Current       Current       Percentage
                Usage in     Prediction    Memlimit      Used to
Name     ASID   Megabytes    in Megabytes  in Megabytes  Capacity
________ ____ ___________ _____________ _____________ __________
ABZTT06  002D         10K         68048         20384         50%

                           Rate of
                           Increase Per    Start Date and
Job                        Minute for      Time of
Name     ASID Area         Current Trend   Current Trend
________ ____ ________ _____________ ___________________
ABZTT06  002D *ABV2G            451M   10/05/2020 17:04:45
```

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SECTION 2: ADDRESS SPACE DETAILED DATA

Job name:  ABZTT06
ASID    :  002D
 Extended User Private Area (Above 16M line):
   Total capacity in number of kilobytes            :     1468104
   Current size in number of kilobytes              :       10332
   Current usage in number of kilobytes             :       10328
   Percentage of current usage to current size      :        100%
   Percentage of current usage to total capacity    :          1%
   Percentage of current size to total capacity     :          1%
   Predicted usage                                  : Not modeled
   Currently available between EUSER and EAUTH in
     number of kilobytes                            :     1457772
   Percentage of available between to total capacity:         99%
   Extended LSQA/SWA/229/230 Area (EAUTH):
     Current capacity in number of kilobytes        :     1459688
     Current size in number of kilobytes            :        1916
     Current size in number of kilobytes            :        1916
     Current usage in number of kilobytes           :        1912
     Percentage of current usage to current size    :        100%
     Percentage of current usage to current capacity:          0%
     Percentage of current usage to total capacity  :          0%
     Percentage of current size to total capacity   :          0%
     Predicted usage                                : Not modeled
     Offset to current bottom of EAUTH area in
       number of kilobytes                          :     1466188
   Extended User Region (EUSER):
     Current capacity in number of kilobytes        :     1466188
     Current size in number of kilobytes            :        8416
     Current usage in number of kilobytes           :        8416
     Percentage of current usage to current size    :        100%
     Percentage of current usage to current capacity:          1%
     Percentage of current usage to total capacity  :          1%
     Percentage of current size to total capacity   :          1%
     Predicted usage                                : Not modeled
     Offset to current top of EUSER region in
       number of kilobytes                          :        8416
     Defined region limit in number of kilobytes    :     1475584
```

Usage & Invocation – slide 4 of 6

3 and 4

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User Private Area (Below 16M line):
  Total capacity in number of kilobytes             :        9192
  Current size in number of kilobytes               :         160
  Current usage in number of kilobytes              :         160
  Percentage of current usage to current size       :        100%
  Percentage of current usage to total capacity     :          2%
  Percentage of current size to total capacity      :          2%
  Predicted usage                                   : Not modeled
  Currently available between USER and AUTH in
    number of kilobytes                             :        9032
  Percentage of available between to total capacity:          98%
  LSQA/SWA/229/230 Area (AUTH):
    Current capacity in number of kilobytes         :        9188
    Current size in number of kilobytes             :         156
    Current usage in number of kilobytes            :         156
    Percentage of current usage to current size     :        100%
    Percentage of current usage to current capacity:          2%
    Percentage of current usage to total capacity   :          2%
    Percentage of current size to total capacity    :          2%
    Predicted usage                                 : Not modeled
    Offset to current bottom of AUTH area in
      number of kilobytes                           :        9036
  User Region (USER):
    Current capacity in number of kilobytes         :        9036
    Current size in number of kilobytes             :           4
    Current usage in number of kilobytes            :           4
    Percentage of current usage to current size     :        100%
    Percentage of current usage to current capacity:          0%
    Percentage of current usage to total capacity   :          0%
    Percentage of current size to total capacity    :          0%
    Predicted usage                                 : Not modeled
    Offset to current top of USER region in
      number of kilobytes                           :           4
    Defined region limit in number of kilobytes     :        9192
Above the 2 gigabyte bar:
  Current memlimit in number of megabytes           :       20384
  Current usage in number of megabytes              :         10K
  Percentage of current usage to current memlimit   :          50%
  Predicted usage in number of megabytes            :       68048
  Memlimit source                                   : Authorized Pgm
```

6

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SECTION 3: RUNTIME DIAGNOSTICS OUTPUT

Runtime Diagnostics detected a problem in ASID:   002D
EVENT 1: HIGH:SERVERHEALTH     SYSTEM: SY1      2020/10/05 17:15:43
  JOB NAME: ABZTT06   ASID: 002D  CURRENT HEALTH VALUE: 50
  CURRENT LOWEST HEALTH VALUES:
             SUBSYSTEM   HEALTH                    REPORTED
  SUBSYSTEM  NAME        SETTING           REASON  DATE AND TIME
  HZR        FHBRSPSE        50        Set to 50.  2020/10/05 16:59:09
ERROR : ADDRESS SPACE SERVER CURRENT HEALTH VALUE LESS THAN 100.
ERROR : THIS VALUE MAY IMPACT YOUR SYSTEM OR SYSPLEX TRANSACTION
ERROR : PROCESSING.
ACTION: USE YOUR SOFTWARE MONITORS TO INVESTIGATE THE ASID AND TO
ACTION: DETERMINE THE IMPACT OF THE HEALTH OF THE ADDRESS SPACE TO
ACTION: OVERALL TRANSACTION PROCESSING.
------------------------------------------------------------------------


 * Medium Severity Exception *

AIRH222E The private virtual storage usage for one or more address
spaces has been predicted to exceed the capacity by
10/05/2020 18:39:46.

  Explanation:  The check is looking to see if there is a potential for
    private virtual storage to be exhausted by an address space by the
    end of the next model interval. The model of private virtual storage
    utilization has predicted that usage for one or more address spaces
    on this LPAR will exceed the capacity by 10/05/2020 18:39:46. The
    prediction was modeled at 10/05/2020 17:15:19.

  System Action:  Subsequent runs of this check will not produce an
    operator message until new data is available.
```

Usage & Invocation – slide 5 of 6

7

Operator Response:

1. Examine SECTION 1: PRIVATE VIRTUAL STORAGE USAGE DATA in the report above which lists the address spaces that have the potential to exhaust their private virtual storage by the end of the next model interval. The report lists the storage area with the potential to be exhausted along with the address space's current usage, current prediction, current capacity and the percentage used to the capacity which is a way of showing how close the address space is to exhausting storage.

2. Examine SECTION 2: ADDRESS SPACE DETAILED DATA in the report above. It contains the detailed values of each storage area for the address space. Use the figures located in the z/OS Problem Management book, Predictive Failure Analysis Checks chapter, PFA_PRIVATE_STORAGE_EXHAUSTION subsection, in the 'Best Practices' topic to aid in understanding the values and how they can be used to aid in the investigation of the problem.

3. Create a graph of private virtual storage usage for the address causing the exception in the storage locations causing the exception. Check the graph for usage patterns to detect when the anomaly started. Determine whether this is a large consumer with a spike, leak, or creep in usage. IBM has provided Python scripts that can be used to graph this resource usage over time. These graphs can be very helpful in determining the root cause of the problem. This code is provided 'as-is' and can be found on the IBM GitHub page. See the 'Graphing Exhaustion Data' section in z/OS Problem Management for more details.

4. Check the logs including the SYSLOG, OPERLOG, LOGREC, and the job's joblog. Search for error messages indicating a repeating problem which could consume and orphan address space private storage. If a problem is found, see if you can resolve the problem and allow storage usage to stabilize.

5. Examine SECTION 3: RUNTIME DIAGNOSTICS OUTPUT for each address space for which it has been provided. Perform the ACTION steps in the output. If no Runtime Diagnostics output is provided for an address space listed, Runtime Diagnostics didn't find any events for it.

6. Examine the IBM Health Checker for z/OS log for related exceptions in other checks.

7. See if any SVC dumps have been taken recently for existing problems.

8. If the problem remains unknown and your local guidelines allow you to initiate a dump, take an SVC dump of the address spaces before they terminate and include the RASP address space by modifying this check's DEBUG parameter to DEBUG(1) or by taking the SVC dump manually. If the DEBUG parameter is set to 1 and this problem continues to occur, PFA will dump the address spaces causing the exception, the PFA address space, and the RASP address space automatically in the comparison interval when a new WTO exception is issued and then at the next comparison interval after it if the exception continues to occur. You can compare the two sets of dumps to see where the storage is continuing to increase. Change DEBUG to DEBUG(0) after the dumps have been taken.

When reviewing the dumps, investigate the control block information or the owncomm information in detail using the command 'IP VERBX VSMDATA' with the appropriate parameters. See the 'MVS Interactive Problem Control System (IPCS) Commands' book for more information on that command. If the address space causing the storage increase is a system address space, open a Case with IBM Service to determine the root cause.

To set the DEBUG parameter to 1, use the following command:

```
f hzsproc,update,check(IBMPFA,PFA_PRIVATE_STORAGE_EXHAUSTION),
parm('debug(1)')
```

9. Determine what work is dependent on the address spaces and its business importance. Follow your installation restart procedures to determine whether to restart the address space.

10. To find additional recommendations, consult the z/OS Problem Management book, Predictive Failure Analysis checks chapter, PFA_PRIVATE_STORAGE_EXHAUSTION subsection, in the 'Best Practices' topic.

Usage & Invocation – slide 6 of 6

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11. If the problem cannot be easily determined in a short amount of
time and you want to stop all exceptions until the problem can be
resolved, do one of the following:

  a. Quiesce the check so that data continues to be collected, but
comparisons are not performed. Quiescing the check allows the check
to resume processing with no interruption of collected data once the
check is reactivated. First, ensure the check will collect and model
data while deactivated by setting COLLECTINACTIVE to 1 and then

deactivate the check.

  f hzsproc,update,check(IBMPFA,PFA_PRIVATE_STORAGE_EXHAUSTION),
  parm('collectinactive(1)')

  f hzsproc,deactivate,check(IBMPFA,PFA_PRIVATE_STORAGE_EXHAUSTION)

  b. Change the severity of the exception so that all processing
continues for this check, but exceptions are not issued by modifying
the dynamic severity parameters for this check by setting these
parameters so that all exceptions issued by this check use no
severity. Use the command below or establish an IBM Health Checker
for z/OS PARMLIB member to make the change persistent:

  f hzsproc,update,check(IBMPFA,PFA_PRIVATE_STORAGE_EXHAUSTION),
  parm('e_high(unused) e_med(unused) e_low(unused) e_none(max)')

12. After investigating the problem, if you have determined that the
exception is normal operating behavior and you do not want to be
alerted for similar data in the future, perform one or more of the
following actions:

  a. If this check continues to issue exceptions for address spaces
whose private storage appears to have the potential to be exhausted
but are operating normally, add the address spaces to the
EXCLUDED_JOBS file. The file is found in the
pfa_directory/PFA_PRIVATE_STORAGE_EXHAUSTION/config directory where
'pfa_directory' is the name of your PFA directory. Update the file
and then force PFA to read the file by issuing the following
command:

  f pfa,update,check(PFA_PRIVATE_STORAGE_EXHAUSTION),EXCLUDED_JOBS
```

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  b. Modify this check's COMP% parameter to a higher value. This
parameter indicates the percentage of the current capacity used for
that value that defines exhaustion. For example, a value of 102
indicates that 102 percent of the capacity is used in the
calculations using capacity rather than 100 percent and that the
prediction must be at least 102 percent of the current capacity
before comparisons will be performed which makes exceptions less
frequent. Setting the COMP% too high might cause exhaustion problems
to be undetected. Setting the COMP% too low might cause more
undesired exceptions. Use the command below and specify your desired
value in place of the X or establish an IBM Health Checker for z/OS
PARMLIB member to make the change persistent:

  f hzsproc,update,check(IBMPFA,PFA_PRIVATE_STORAGE_EXHAUSTION),
  parm('comp%(X)')

  c. Modify this check's dynamic severity parameters by using the
IBM Health Checker for z/OS modify command. These parameters
determine the severity of the WTO issued when this check detects the
potential for future exhaustion. The severity is based on the number
of minutes until exhaustion would occur with a steady increase of
usage such that the severity increases the closer the system is to
resource exhaustion. The number of minutes is specified in the
E_HIGH, E_MED, E_LOW, and E_NONE parameters. Use the command below
and specify your desired values in place of X or establish an IBM
Health Checker for z/OS PARMLIB member to make the change
persistent:

  f hzsproc,update,check(IBMPFA,PFA_PRIVATE_STORAGE_EXHAUSTION),
  parm('e_high(X) e_med(X) e_low(X) e_none(X)')
```

Interactions & Dependencies

- Software Dependencies
  - None
- Hardware Dependencies
  - None
- Exploiters
  - None

Upgrade & Coexistence Considerations

- To exploit this solution, all systems in the sysplex must be at the new z/OS level: No
- List any toleration/coexistence APARs/PTFs: None

Installation & Configuration

- Nothing new.
  - The check is automatically added to IBM Health Checker for z/OS when PFA starts.
  - If you have not previously used PFA, see the chapter entitled *Predictive Failure Analysis overview and installation* in *z/OS Problem Management* (also listed in the Appendix of this presentation).

Summary

- Predictive Failure Analysis (PFA) has enhanced the check PFA_PRIVATE_STORAGE_EXHAUSTION to detect and alert you to the potential for future exhaustion of private storage above the 2G bar.
- This check’s report contains data to investigate the problem and take appropriate action to avoid outages.

Appendix

- *z/OS Problem Management SC23-6844*