Rule WLM356: Device PEND time was a major cause of DASD I/O delay

Finding: CPExpert has determined that device PEND time was a major cause of delay in DASD response for the I/O operations of the service class.

This finding applies only to MVS versions prior to OS/390 Release 3, and to MVS versions with OS/390 Release 3 if I/O Priority Management has **not** been specified.

Impact: This finding may have a MEDIUM IMPACT or HIGH IMPACT on the performance of the service class.

Logic flow: The following rules cause this rule to be invoked:

Rule WLM350:	I/O activity may have caused significant delays
Rule WLM351:	I/O activity may have caused significant delays
Rule WLM352:	I/O activity may have caused significant delays for server service class
Rule WLM353:	I/O activity may have caused significant delays for server service class

Discussion: PEND time is the time from the issuance of the SSCH instruction until the device is selected by the control unit. This time is caused by queuing for the path (wait for channel, wait for control unit or wait for head-of-string), and can be caused by other systems sharing the device (wait for device).

CPExpert computes the average per-second PEND delay time as described in Rule WLM350. Rule WLM356 is produced if the average PEND time accounted for a significant percent of the response time of transactions in the service class missing its performance goal.

The following example illustrates the output from Rule WLM356:

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RULE WLM356: DEVICE PEND TIME WAS A MAJOR CAUSE OF DASD DELAYS

   A major part of the potential I/O delay to the ST_USER Service Class
   could be attributed to device pending (PEND) time.  Pending time is
   caused by queuing for the path (wait for channel, wait for control unit
   or wait for head-of-string).  The queuing can be caused by other systems
   sharing the device (wait for device).  Large PEND times for devices that
   are not shared may mean that there are insufficient paths available to
   the device.  Please refer to the WLM Component User Manual for advice on
   how to minimize device PEND time.
```


Suggestion: Large device PEND times usually involve the following situations:

- **Shared devices**. If the device is shared with another system, PEND time may indicate contention with the other system. Large PEND times in shared-device environments usually involve situations very similar to those described under IOSQ time:

  - **Multiple data sets active on the volume**. This situation is the most common and easiest to solve. The data sets can be redistributed among different volumes, to eliminate the queuing at the channel level (reflected as PEND time) for the single volume.

    If some of the data sets are not required to be shared, then the Data Base Administrator has complete flexibility to move these data sets (subject, of course, to the performance implications of the target devices). These data sets should be moved to a non-shared device.

    If the data sets are required to be shared, then they must be relocated to shared devices.

  - **Multiple applications or users using the same data set on the volume**. Depending upon the data set characteristics, duplicate copies of the data set may be placed on different volumes. This would solve the PEND problems cause by contending systems. If this option is feasible, the data sets could be placed on non-shared devices, likely resulting in even more performance improvement.

  - **Multiple application systems may be using the volume experiencing high PEND times**. In this case, perhaps application redesign or scheduling can solve the problem.

  Additionally, large PEND times for shared devices could be caused by RESERVE from the other system. The applications issuing the RESERVE should be examined to determine whether the RESERVE is required. If the RESERVE **is** required, the above situations should reviewed to determine whether improvements can be achieved.

- **Non-shared devices**. Large PEND times for devices that are not shared may mean that there are insufficient paths available to the device. Too much I/O may be directed to many devices on the path, control unit, or head-of-string. The data sets can be redistributed among different volumes on different paths, control units, or heads-of-string. This will reduce the hardware-level queuing. Alternatively, the entire volume may be moved to a different (less busy) head-of-string or path.

If redistributing the data sets or moving the volume is not feasible, then the device should have more paths. Depending upon the existing configuration, this may involve re-configuring existing channel paths, or acquiring additional hardware.

- **Devices attached to cached controllers**. Large PEND times for devices attached to cached controllers may imply a high percent of read miss operations, or non-volatile storage (NVS) writes for IBM-3990-3 devices. Fairchild [1] lists four ways in which staging in caching controllers can cause hidden device busy (with the device busy potentially reflected in high PEND time):

  - The normal (random) caching algorithm stages all records to the end of the track after a requested record is read.

  - The normal (random) caching algorithm stages all records from the beginning of the track to the requested record if a front-end miss occurs.

  - Most writes to extended function IBM-3990 (Model 3) go into NVS with a subsequent destaging required.

  - The sequential caching algorithm stages all records to the end of the track after the requested record is read, and stages in all of the next track. IBM-3990 (Model 3) controllers stages in all of the next three tracks.

- **Dual Copy Initialize**. Large PEND times for IBM-3390 devices may be caused by dual copy initialize. In this case, the dual copy initialize should be turned off.

[1] Fairchild, Bill, "The Anatomy of an I/O Request", *Conference Proceedings*, CMG'90, the Computer Measurement Group, Chicago, IL.

