How to improve IMS Scheduling

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Agenda

What is IMS scheduling?

Elements that affect IMS scheduling

Monitoring IMS scheduling
What is IMS Scheduling?

The life of a full-function IMS transaction (message)

- Message arrives in IMS
- Enqueue the message to the SMB
- Schedule the message
- Schedule-end to first DL/I call
- Program elapse
- Syncpoint
- Output message
A more convenient way to look at the log records related to a unit of work

<table>
<thead>
<tr>
<th>Code</th>
<th>Type</th>
<th>Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>input msg</td>
<td>origins=I15Z destims=I15Z origin=RIHLXT dest=IVTNO</td>
</tr>
<tr>
<td>08</td>
<td>msg enqueue</td>
<td>dest=IVTNO drrn=0400001D</td>
</tr>
<tr>
<td>07</td>
<td>pgm start</td>
<td>recovery token=I15Z 000000002000000000 tran=IVTNO</td>
</tr>
<tr>
<td>25</td>
<td>msg enqueue</td>
<td>(start unit-of-recovery) psb=DFSIVP1</td>
</tr>
<tr>
<td>31</td>
<td>msg get</td>
<td>recovery token=I15Z 000000002000000000 dest=IVTNO</td>
</tr>
<tr>
<td>36</td>
<td>msg return</td>
<td>(Input message returned to msg Q) qlriflgs=01 qlriflgs2=00</td>
</tr>
<tr>
<td>35</td>
<td>msg enqueue</td>
<td>dest=IVTNO drrn=0400001D psb=000001</td>
</tr>
<tr>
<td>38</td>
<td>msg return</td>
<td>(Input message returned to msg Q) qlriflgs=01 qlriflgs2=00</td>
</tr>
<tr>
<td>FA</td>
<td>Mainview</td>
<td>tran=IVTNO jobname=IMSM15Z userid=RIHLXT ver=5300</td>
</tr>
<tr>
<td>E9</td>
<td>Mainview</td>
<td>jobname=IMSM15Z pst=00001 psb=DFSIVP1 tran=IVTNO</td>
</tr>
<tr>
<td>07</td>
<td>pgm end</td>
<td>abendcode=U3303 psb=DFSIVP1 tran=IVTNO pst=00001</td>
</tr>
</tbody>
</table>

Bottom of Data
What is IMS Scheduling?

Schedule-to-1\textsuperscript{st} DL/I call time

- Phase 1: Scheduling the message
  - IMS Scheduler examines the following elements
    - SERIAL/PARALLEL, MAXRGN, PARLIM, PROCLIM, PRIORITY, CLASS
  - Pool allocation
    - PSB/DMB directory (PDIR/DDIR) and PSBW pool
      » If PSB not resident, I/Os to ACBLIB
      » If pool space not available, intent failure
  - Schedule the message to MPR
What is IMS Scheduling?

Schedule-to-1\textsuperscript{st} DL/I call time (cont’d)

– Phase 2: Schedule-end to first DL/I call
  • Program & subroutine load from PGMLIB
  • Program initialization
  • Program does the first DL/I call to the I/O PCB
What is IMS Scheduling?

Our goal for today’s session is to:

- Reduce the message scheduling time
- Reduce or eliminate the Schedule-end to first DL/I call time

Results

- Improve transaction response time
- Reduce CPU utilization
- Increase transaction throughput
- Meet SLA with minimum resource requirement
Elements that affect Scheduling

Define program SERIAL/PARALLEL (APPLCTN/CREATE PGM)

– Definition
  • Use SERIAL for application required serialization for a business reason
  • PARALLEL allows transaction to be scheduled in multiple MPRs

– Recommendation: Use PARALLEL

– Advantages
  • Less message queuing for high-volume transaction
  • Improve transaction response time
  • Handle high-volume transaction

– Disadvantages
  • Increase database locking contention or deadlock
Elements that affect Scheduling

Define MAXRGN=x for parallel scheduling (TRANSACTION/CREATE TRAN)

- Definition
  - Set the maximum number of regions that a transaction can run concurrently
  - Controls domination of a transaction in a class
- Recommendation: It depends on the transaction volume during peak time
- Advantages
  - Allows more concurrency
  - Handle high-volume transaction
- Disadvantage
  - Setting value x too high will cause IMS scheduling to be more complex thus causing high CPU usage for the control region
  - Increased possibility for locking conflicts
Elements that affect Scheduling

Define PSB as RESIDENT/Non-Resident

- Recommendation: Define PSB as RESIDENT
  - Use 64-bit ACB storage pool to reduce I/Os (ACBIN64=n)

- Advantage
  - Reduce I/Os to the ACBLIB

- Disadvantage
  - For non-active PSB, it occupies real/virtual storage (working set size). But in today’s system, real/virtual storage is less of an issue
Elements that affect Scheduling

Define PROCLIM=(x,y) for limiting transaction scheduling or by CPU time

- **Definition**
  - Set the limit number of messages that can be executed in one schedule for a transaction
  - When the limit is reached, the program is ended unless it is eligible for a quick re-scheduling
  - Set PROCLIM=0 for program that does not perform storage clean up properly

- **Recommendation**: Set a high value for a high volume transaction

- **Advantages**
  - Reduce IMS scheduling time
  - Reduce program load time
  - Reduce CPU utilization
  - Reduce Db2 thread creation time

- **Disadvantage**
  - The transaction can dominate the MPR
Elements that affect Scheduling

Define PARLIM=x for parallel transaction scheduling

– Definition
  • Set the queue count that triggers parallel scheduling of a transaction
  • PARLIM=0 implies scheduling right away
  • In a shared-queue environment, IMS does not know the queue depth. It performs another schedule after a successful GU I/O PCB

– Recommendation: PARLIM=0 for non shared-queue and =2 for shared queue

– Advantage
  • Reduce input queue time

– Disadvantages
  • Scheduling overhead may increase if transaction has long schedule to 1st DL/I time
  • In CQS environment, PARLIM=0 may cause false scheduling
Elements that affect Scheduling

Define PRTY=(normal,limit,limit count) for setting transaction priority when transaction stays in the queue

- **Definition**
  - Specifies the values that determine the scheduling priority of this transaction
  - Normal: Use this value when tran in queue less than limit count (0-14, default is 1)
  - Limit: Use this value when tran in queue equals or greater than limit count
  - Use command to set PRTY to 0 to prevent scheduling

- **Recommendation**: Use default unless there is a good reason

- **Advantages**
  - Reduce input queue time
  - For a certain type of application, this maybe helpful
  - Useful to manage MSC transactions

- **Disadvantage**
  - Complex setting may cause scheduling overhead
Elements that affect Scheduling

Define Wait-for-Input (WFI) for transaction

- **Definition**
  - The transaction is scheduled just like normal. However, the next GU call to the I/O PCB will either get the next message in the queue or IMS will suspend the call (place the ITASK in the suspend queue) until the next message is available
  - The GU call will get the 'QC' status when the PROCLIM limit is reached

- **Recommendation:** Use WFI for transaction accessing Db2 or high volume

- **Advantages**
  - Eliminate the scheduling process for the transaction in the region
  - CPU, I/O, log records will be reduced (no log records x’07’, x’08’)
  - Response time improved

- **Disadvantage**
  - Region is occupied by this transaction
  - Application programs executed in this MPR needs to have correct initialization logic
Elements that affect Scheduling

Define the region (MPR) as Pseudo-Wait-for-Input (PWFI=Y)

– Definition
  • The transaction is scheduled just like normal. However, the next GU call to the I/O PCB will either get the next message in the queue or IMS will suspend the call (place the ITASK in the suspend queue) if there is no eligible message ready to be scheduled in this region.

– Recommendation: Use PWFI as much as you can
  • Strongly recommended for transaction accessing Db2

– Advantages
  • Reduce the scheduling process for the transaction in the region
  • CPU, I/O, log records will be reduced (no log records X’07’, X’08’)
  • Response time improved

– Disadvantage
  • Application programs executed in this MPR need to have correct initialization logic
Elements that affect Scheduling

DMB, PSB (CSA, DLI), PSBW pools

- Definition
  - IMS Scheduler needs to allocate pool space for this transaction
- Recommendation: Monitor these pools and make sure they are large enough to handle the workload during peak
  - If IMS Catalog is used, IMS requires extra space for PSB (DLI & CSA) for each schedule
- Advantage
  - Reduce the scheduling failures such as block-mover wait
- Disadvantage
  - N/A
Elements that affect Scheduling

Program preload

- IMS needs to make the application program ready to run under the MPR; if the program is not in storage, it needs to load the program from the PGMLIB
- Recommendation: Use the DFSMPLxx to preload program and Cobol service routines (language environment modules)
  - Use GTF trace to find module names
- Advantage
  - Reduce/eliminate program load time
- Disadvantage
  - Occupy large storage/working set size especially with multiple regions
Elements that affect Scheduling

PGMLIB

- If program is not in storage, IMS loads from the PGMLIB
- Recommendation
  - Make PGMLIB under VLF or using cache/SSD device
  - Use large blocksize
  - Put RESLIB in the bottom of STEPLIB concatenation
- Advantage
  - Reduce program load time
- Disadvantage
  - N/A
Monitoring IMS Scheduling

IMS DC Monitor Region Summary Report

- Look at the number of occurrences and the mean time (in micro secs)
- What happened to region 3 “schedule to first call” mean time?
- What is the difference between the “scheduling and termination” and “schedule to first call” time?
## Monitoring IMS Scheduling

### IMS DC Monitor Transaction Queuing Report

<table>
<thead>
<tr>
<th>TRANSACTION</th>
<th>DEQUED</th>
<th>SCHEDS.</th>
<th>MINIMUM</th>
<th>MEAN</th>
<th>MAXIMUM</th>
<th>MEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>IVTN No</td>
<td>84</td>
<td>14</td>
<td>0</td>
<td>0.85</td>
<td>1</td>
<td>6.0</td>
</tr>
<tr>
<td>IVTN V</td>
<td>84</td>
<td>39</td>
<td>0</td>
<td>0.48</td>
<td>1</td>
<td>2.1</td>
</tr>
<tr>
<td>THDAMUPD</td>
<td>76</td>
<td>19</td>
<td>0</td>
<td>1.63</td>
<td>3</td>
<td>4.0</td>
</tr>
<tr>
<td>THDAMING</td>
<td>36</td>
<td>17</td>
<td>0</td>
<td>1.23</td>
<td>3</td>
<td>2.1</td>
</tr>
</tbody>
</table>

**No Intent Failures in This Trace**

**No Pool Space Failures in This Trace**

**No Deadlock Events in This Trace**

**Total Times ECBs Waited for SAPS = 0**

**Monitor Overhead Data**

*Small number is better*

*Large number is better*

PSB/PSBW pools are fine
Monitoring IMS Scheduling

IMS DC Monitor Program Summary Report

<table>
<thead>
<tr>
<th>PSBNAME</th>
<th>SCHEDS.</th>
<th>TRANS.</th>
<th>DEQ.</th>
<th>CALLS</th>
<th>CALLS /TRAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>DFSIVP1</td>
<td>14</td>
<td>84</td>
<td>299</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>DFSIVP2</td>
<td>39</td>
<td>84</td>
<td>355</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>PHDAMUPD</td>
<td>19</td>
<td>76</td>
<td>270</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>PHDAMINQ</td>
<td>17</td>
<td>36</td>
<td>254</td>
<td>7.0</td>
<td></td>
</tr>
<tr>
<td>**TOTALS</td>
<td>89</td>
<td>280</td>
<td>1178</td>
<td>4.2</td>
<td></td>
</tr>
</tbody>
</table>

Why such a big number?
A possibility that GU I/O PCB calls were suspended
Was region 3 really much less efficient for program DFSIVP1 than region 1?
DC Monitor not helpful with PWFI!
## Monitoring IMS Scheduling

### Monitor IMS region occupancy percentage

<table>
<thead>
<tr>
<th>CM Rgn</th>
<th>Region</th>
<th>Rgn Rgn MVS</th>
<th>Proc Rgn</th>
<th>Cls %</th>
<th>Cls %</th>
<th>Cls %</th>
<th>Cls %</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>Name</td>
<td>Typ</td>
<td>CPU</td>
<td>CPU</td>
<td>Rate</td>
<td>Occ</td>
<td>Occ</td>
<td>Occ</td>
</tr>
<tr>
<td>2</td>
<td>IMSM14Z</td>
<td>MPP</td>
<td>0</td>
<td>37</td>
<td>0.3</td>
<td>1</td>
<td>10.3</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>IMSM14Z</td>
<td>MPP</td>
<td>0</td>
<td>37</td>
<td>0.3</td>
<td>0</td>
<td>10.2</td>
<td>2</td>
</tr>
</tbody>
</table>

- Good region occupancy rate under 60%
- Any class with low occupancy rate should be removed to make scheduling simple
- Group the removed class to a region (or more) so program preload is more useful
### Monitoring IMS Scheduling

Monitor each class to make sure there are enough regions to execute all transactions in that class.

```
<table>
<thead>
<tr>
<th>Class</th>
<th>1</th>
<th>--Total Msgs---</th>
<th>-Process Stat--</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMS ID.......</td>
<td>I14Z</td>
<td>Avg back Log...</td>
<td>0.00</td>
</tr>
<tr>
<td>SharedQ Group..</td>
<td></td>
<td>Back Log Dir...</td>
<td>Min CPU Time...</td>
</tr>
<tr>
<td>MVS Name....</td>
<td>SJSD</td>
<td>Avg Queue Size.</td>
<td>0.00</td>
</tr>
<tr>
<td>Avg Total Rgns.</td>
<td>2.00</td>
<td>Diff Tran Cd...</td>
<td>0.00</td>
</tr>
<tr>
<td>Avg Enabld Rgns</td>
<td>2.00</td>
<td>--Sched Msgs---</td>
<td>Min Elapse Time</td>
</tr>
<tr>
<td>Avg EnblRgn Occ</td>
<td>0.00</td>
<td>Avg Queue Size.</td>
<td>0.00</td>
</tr>
<tr>
<td>Avg Rgn Delay..</td>
<td>0.00</td>
<td>Diff Tran Cd...</td>
<td>0.00</td>
</tr>
<tr>
<td>Avg Rgns Needed</td>
<td>0.01</td>
<td>-Non-Sched Msg-</td>
<td>Min Queue Time.</td>
</tr>
<tr>
<td>Avg Rgns Used..</td>
<td>0.0</td>
<td>Avg Queue Size.</td>
<td>0.00</td>
</tr>
<tr>
<td>Proc Rgns Used..</td>
<td>1.6</td>
<td>Diff Tran Cd...</td>
<td>0</td>
</tr>
<tr>
<td>Arrival Rate...</td>
<td>1.6</td>
<td>-BMP Msgs.......</td>
<td>Avg Queue Size.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Diff Tran Cd...</td>
</tr>
</tbody>
</table>
```
Monitoring IMS Scheduling

Monitor scheduling time by transaction

---

24FEB2016 07:34:06 ----- MAINVIEW WINDOW INTERFACE (V6.1.01) ------------------

COMMAND ===> SCROLL ===> CSR
CURR WIN ===> 1  ALT WIN ===> 

1W1 =IFCTRS=********I14ZIMS=********24FEB2016=07:34:06=MTVIMS=DDDD3

<table>
<thead>
<tr>
<th>Transcode</th>
<th>ID</th>
<th>Resp</th>
<th>Avg</th>
<th>Avg % Sched</th>
<th>%CPU</th>
<th>CPU</th>
<th>I/O</th>
<th>Pol</th>
<th>Lch</th>
<th>Oth</th>
</tr>
</thead>
<tbody>
<tr>
<td>I14Z</td>
<td>I14</td>
<td>0.136</td>
<td>10</td>
<td>0...........15........30</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I14Z</td>
<td>I14</td>
<td>0.119</td>
<td>2</td>
<td></td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>THDAMINQ</td>
<td>I14</td>
<td>0.174</td>
<td></td>
<td></td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

— Consider making change to the MAXRGN or PROCLIM or PARLIM
— Review your change if it improves
### Monitoring IMS Scheduling

Monitor efficiency of scheduling by tran and region

- Effect of WFI transaction /PWFI region

<table>
<thead>
<tr>
<th>Regn Program</th>
<th>Regn Tran Type Name</th>
<th>Trn Cls</th>
<th>Pgm Scheds</th>
<th>Tran Scheds</th>
<th>Trans IMS /Sched Prld</th>
<th>Scheduling Change Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 DFSIVP1</td>
<td>MPP</td>
<td>IVTNO</td>
<td>71</td>
<td>78</td>
<td>1.10 No</td>
<td>PWFI,PRLD</td>
</tr>
<tr>
<td>1 DFSIVP2</td>
<td>MPP</td>
<td>IVTNY</td>
<td>589</td>
<td>766</td>
<td>1.30 Yes</td>
<td>PWFI</td>
</tr>
<tr>
<td>1 PHDAMINGQ</td>
<td>MPP</td>
<td>THDAMINGQ</td>
<td>18</td>
<td>27</td>
<td>1.50 No</td>
<td>PWFI,PRLD</td>
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<tr>
<td>1 PHDAMUPD</td>
<td>MPP</td>
<td>THDAMUPD</td>
<td>33</td>
<td>66</td>
<td>2.00 No</td>
<td>PWFI,PRLD</td>
</tr>
<tr>
<td>2 DFSIVP1</td>
<td>PWFI</td>
<td>IVTNO</td>
<td>14</td>
<td>1400</td>
<td>100.00 No</td>
<td>PRLD</td>
</tr>
<tr>
<td>2 DFSIVP2</td>
<td>PWFI</td>
<td>IVTNY</td>
<td>25</td>
<td>363</td>
<td>14.52 Yes</td>
<td>PRLD</td>
</tr>
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<td>2 PHDAMINGQ</td>
<td>PWFI</td>
<td>THDAMINGQ</td>
<td>3</td>
<td>5</td>
<td>1.67 No</td>
<td>PRLD</td>
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<td>2 PHDAMUPD</td>
<td>PWFI</td>
<td>THDAMUPD</td>
<td>1</td>
<td>4</td>
<td>4.00 No</td>
<td>PRLD</td>
</tr>
<tr>
<td>3 DFSIVP1</td>
<td>MPP</td>
<td>IVTNO</td>
<td>180</td>
<td>298</td>
<td>1.66 No</td>
<td>PWFI,PRLD</td>
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<tr>
<td>3 DFSIVP2</td>
<td>MPP</td>
<td>IVTNY</td>
<td>477</td>
<td>518</td>
<td>1.09 Yes</td>
<td>PWFI</td>
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<tr>
<td>3 PHDAMINGQ</td>
<td>MPP</td>
<td>THDAMINGQ</td>
<td>15</td>
<td>22</td>
<td>1.47 No</td>
<td>PWFI,PRLD</td>
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<tr>
<td>3 PHDAMUPD</td>
<td>MPP</td>
<td>THDAMUPD</td>
<td>47</td>
<td>92</td>
<td>1.96 No</td>
<td>PWFI,PRLD</td>
</tr>
</tbody>
</table>
### Monitoring IMS Scheduling

#### Monitor 1st DLI Time

- High 1st DLI, but low CPU indicates program load ➔ consider preload

<table>
<thead>
<tr>
<th>Regn Id</th>
<th>Scheduling Change Recommendations</th>
<th>Program Size</th>
<th>Total 1st DLI</th>
<th>Total 1st DB2</th>
<th>Trn Proc</th>
<th>Par Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PWFI, PRLD</td>
<td>3944</td>
<td>21.88</td>
<td>69.56</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>PRCL, PARL</td>
<td>21.88</td>
<td>69.56</td>
<td>No</td>
<td>No</td>
<td>5 65535</td>
</tr>
<tr>
<td>1</td>
<td>PWFI</td>
<td>3944</td>
<td>34.57</td>
<td>52.47</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>WFI, PARL</td>
<td>34.57</td>
<td>52.47</td>
<td>No</td>
<td>No</td>
<td>65535 65535</td>
</tr>
<tr>
<td>1</td>
<td>PWFI, PRLD</td>
<td>18112</td>
<td>110.83</td>
<td>1093.05</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>PRCL</td>
<td>110.83</td>
<td>1093.05</td>
<td>No</td>
<td>No</td>
<td>5 1</td>
</tr>
<tr>
<td>1</td>
<td>PWFI, PRLD</td>
<td>18112</td>
<td>110.83</td>
<td>1093.05</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>PARL</td>
<td>13.24</td>
<td>62.27</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>1</td>
<td>PWFI, PRLD</td>
<td>3944</td>
<td>13.24</td>
<td>62.27</td>
<td>No</td>
<td>65535 65535</td>
</tr>
<tr>
<td></td>
<td>PARL</td>
<td>13.24</td>
<td>62.27</td>
<td>No</td>
<td>No</td>
<td>65535 65535</td>
</tr>
<tr>
<td>2</td>
<td>PRLD</td>
<td>3944</td>
<td>4.16</td>
<td>13.49</td>
<td>n/a</td>
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Monitoring IMS Scheduling

Find candidates for preload

- Use GTF to monitor program load SVC 8 and SVC 122 for language environment
- GTF input parameters

```
000001 TRACE=JOBNAMEP,SVCP
000002 *-----------------------------------------------
000003 JOBNAME=IMSI14Z
000004 *-----------------------------------------------
000005 * SVC
000006 *-----------------------------------------------
000007 SVC=(8,122)
000008 END
```
- Start GTF
  `/S GTF.GTF`
- Stop GTF
  `/P GTF`
Monitoring IMS Scheduling

Evaluate GTF output to find candidates for preload

- Use TSO IPCS to print the GTF trace dataset

```
SDFS OUTPUT DISPLAY RIHLXGTG JOB00680 DSID 106 LINE 254 COLUMNS 01-80 COMMAND INPUT ===> SCROLL ===> CSR
0 SVC.... 008 ASCB.... 00F5A700 CPU.... 0001 JOBNAME. IMSM14Z OLD-PS
0 TCB.... 005D0A90 MODN.... DFSPPCC20 R15.... 00000000 R0....
    EPDENAME DFSIVP1
 GMT-02/10/2016 14:39:30.312177 LOC-02/10/2016 06:39:30.312177
0 SVCRT.... 008 ASCB.... 00F5A700 CPU.... 0001 JOBN.... IMSM14Z DSP-PS
0 TCB.... 005D0A90 MODN.... DFSPPCC20 R15.... 00000000 R0....
 GMT-02/10/2016 14:39:30.313163 LOC-02/10/2016 06:39:30.313163
```

- Find the application program(s) that has high number of loads
Conclusion

Monitor frequently
- Make sure region occupancy for all regions does not exceed 60%
- Provide enough regions to serve each class
- PSB (CSA, DLI) and PSBW pools are large enough during peak time
- Check input queue time for each transaction
- Run GTF trace for new application for preload decision
- Monitor schedule-to-1st DL/I time for each transaction
- Consider using WFI/PWFI for transaction/region

Make change and monitor again
- Look at the big picture
- Monitor virtual storage usage of region after WFI/PWFI change
- Did my change make it better or worse?
Thank you !