IBM’s RMF V5.1 and Boole & Babbage’s CMF V5.2 provide support for the WLM goal mode measurements. While other products also collect and report WLM data, this discussion is limited to the products that produce the SMF type 72 records. This new (and wonderful!) WLM data will provide you with a much better understanding of how your workloads are faring.

I’ll use RMF as a basis for most of this discussion, but would like to summarize both the RMF and CMF terminology at this point. RMF is composed of the base RMF address space; RMF Monitor I, which collects data traditionally for postprocessing; RMF Monitor II, which is typically used as an online monitor to analyze address spaces and current system resource usage, and also creates SMF type 79 records; RMF Monitor III, which is an online monitor to collect delay and resource usage information; and the RMF Postprocessor, which produces reports from the SMF records.

CMF, from Boole & Babbage, is marketed as a replacement for RMF. It produces the same SMF records as RMF, but is architecturally a bit different. The CMF Extractor performs the recording of all SMF records and produces the same format as the RMF records. CMF Online is the component of CMF that corresponds to RMF Monitor III, and CMFMON is the component of CMF that corresponds to RMF Monitor II. The CMF Reporter corresponds to the RMF Postprocessor.

During compatibility mode in SP 5, the using and delay samples that are used in the calculation for execution velocity are stored in the type 72, subtype 1 record for each performance group period. This is new data that was added for SP 5 in both RMF and CMF. The execution velocities shown in compatibility mode can then be used as guidelines when setting velocity goals for goal mode.

In both compatibility mode and previous MVS releases, RMF Monitor I and CMF write an SMF type 72, subtype 1 record for every control and report performance group each interval. In goal mode, RMF Monitor I and CMF write an SMF type 72, subtype 3 record for every service class and report class each interval.

When you switch from compatibility mode to goal mode, the type 72, subtype 1 record for each performance group is written out, and recording continues with type 72, subtype 3 (goal mode). The basic difference is that subtype 1 is based on performance groups and subtype 3 is based on service classes, but the resource data is almost identical.

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**WLM WORKLOAD ACTIVITY REPORT NOT AUTOMATIC IN RMF!**

A somewhat frustrating situation occurs when requesting reports. The RMF postprocessor doesn’t include the WLM reports when you specify REPORTS(ALL). When running in goal mode, you’ll need to indicate that WLM reports are wanted by including SYSRPTS(WLMGL) in addition to REPORTS(ALL). The RMF V5 Postprocessor also requires that the SMF data now be sorted (you can’t simply concatenate several SMF datasets). The RMF V5 User’s Guide (GC33–6483) includes the JCL for the sort in chapter 17, and there’s a sample job in SYS1.SAMPLIB(ERBSAMPP). There is an APAR, OW090975, that allows you to process data from a single system without needing to sort the records.

The SYSRPTS(WLMGL(suboptions)) parameter can be used to produce a selective workload activity report. “Suboptions” can be the following:

- SCPER(xxx) – Service class periods
- SCLASS(xxx) – Service classes
- WGROUP(xxx) – Workload summary
- POLICY(xxx) – Policy
- WGPER(xxx) – Workload by periods (This is the default)
- RCLASS(xxx) – Report class
- SYSNAM(xxx) – System names

where ‘xxx’ is one or more of the items to be reported. For example, you could request a report of just the online workload, ONLINE, from a service policy with any of the following parameters:
The difference in the reports is the organization and summarization. The WGROUP statement will provide a single set of resource data fields, such as CPU and storage, for the combined work in the workload called ONLINE. The WGPER will produce reports for all service class periods in the service class that belongs to the workload called ONLINE. The SCLASS statement will provide a summary of the resource usage for all periods in the service classes listed. Additionally, the SCPER statement will provide reports for each period, along with a service class summary of all service classes listed in the statement.

The POLICY option provides a single summary of all the workloads during the interval, similar to the compatibility Workload Activity report for the System Summary.

If you use a single system’s SMF records into the RMF report job, you’ll get a report for just that system. If you are running in a sysplex environment, and use multiple systems as input to RMF, you’ll get a sysplex report with the data summarized from all systems. If, for example, you had test batch running on three systems in a sysplex configuration, the service class for test batch would show the resources used on all of the systems. You can feed multiple systems into RMF, but be selective by defining the system names in the SYSNAM suboption. If SYSNAM is used, only data from those systems will be combined in the report.

If options aren’t specified, SYSRPTS(WLMGL) will report on all workloads (WGPER), with their associated service classes and periods. If you want to see the report classes and a policy summary, you’ll need to specify SYSRPTS(WLMGL(WGPER,RCLASS,POLICY)).

**TYPE 72, SUBTYPE 3**

Many new response time fields are found for every service class period in the type 72, subtype 3 record. To gain a better understanding, I’ll be describing the reports shown in Figures 1 and 2. These represent three pages from the RMF Workload Activity Report for a TSO service class. A similar report for a single period from a CMF report is shown in Figure 3. This article describes the data from the RMF report shown in Figures 1 and 2. The field names, as it appears in the report, is indicated in bold. If CMF uses a different name, the field name is shown as [CMF: fieldname].

**REPORT BY...**

The first line ('REPORT BY: POLICY-STANDARD...') identifies the reporting summary for the lines shown below (until the next ‘REPORT BY’ line). In Figure 1, the first “REPORT BY” contains data for the following: the policy in force is the STANDARD policy, the workload name is TSO, the service class is TSOPRD, there is no resource group, the data is for period one, and this period has an importance of 1 (highest).

The next three “REPORT BY” lines identify TSO periods 2, 3, and 4. This is followed by
RESOURCE USAGE AND RATES

The resource usage and rates (transaction rate, paging rates, etc.) are identical to the compatibility mode reports (and SP 4 reports), except for the order of the columns. The rightmost columns from compatibility mode (TRANSACTIONS TIMES and TRANSACTIONS) have been moved to the left side. One additional field, EXECUTD, has been added that is used by subsystems such as CICS. That field is described in the section on subsystem reporting. All of the other resource usage and rate fields remain the same as in compatibility mode.

It’s important to understand the difference in the reported response times in this section (TRANSACTION TIME). The EXECUTION response time is the elapsed time from the start of execution to its termination. This time does not include queue time, or printing and routing of output after execution completes. QUEUED time is the amount of time from the time the job was read in (or entered this system from a remote location) or the user attempted to logon until execution started.

For JES batch jobs, this is the time waiting for an initiator or being held. For TSO users, it’s the time waiting for the LOGON to start processing (such as waiting for LOGON PROCEEDING). The QUEUED times are reported in the interval where the job completed execution; thus it’s possible to see QUEUED times in other than first period. The ACTUAL response time is the sum of EXECUTION and QUEUED.

While not shown in this example, the RMF reports for RMF V5.2 contain a little difference in the reported CPU times. In addition to the TCB and SRB seconds, you’ll also find fields containing seconds for RCT (region control task CPU time), IIT (I/O interrupt time), and

**Figure 2: RMF WLMGL (TSO Period 3, Service Class, Workload)**

**Figure 3: CMF WLM Detail**
RESPONSE TIME

Below the resource usage section you’ll find four lines of goal data. The GOALS line [CMF: GOAL column in CMF] has the goal that you assigned to the service class period. If you only see response time, as indicated by HH.MM.SS.TTT, then the response goal type is ‘average’. If the response time is followed by a percent, then it’s a percentile goal. In our example, first period TSO has a goal of .5 second response time for 90 percent of the transactions. If the goal is a velocity goal, the HH.MM.SS.TTT column will be blank. (The response time can be obtained from the ACTUAL section in the resource section.)

The velocity goal is shown under the EXECUTION VEL. column [CMF: EXECUTION VEL.]. A discretionary goal shows the word ‘DISCRETIONARY.’ ‘SYSTEM’ will show up as the goal type for system service classes SYSTEM and SYSSTC.

The ACTUALS line [CMF: ACTUAL column] contains the most valuable information on the report. If you’ve defined an average response time goal or a percentile response time goal, the HH.MM.SS.TTT column contains the average response time. In our example from Figure 1, for period 1, the actual average response time was .116 seconds. For percentile goals, the field (98.0 percent in Figure 1, period 1) under the percentile goal percent (90 percent) is the percent of transactions that actually completed in less than or equal to the goal response time. In our example, the goal was to have 90 percent of the transactions complete in .5 seconds. Actually, 98.0 percent of them completed in less than or equal to .5 seconds.

If you use a single system’s SMF records into the RMF report job, you’ll get a report for just that system. If you are running in a sysplex environment, and use multiple systems as input to RMF, you’ll get a sysplex report with the data summarized from all systems.

The execution velocity, EX VEL, for the service class period during this interval is provided for every period (except periods that contain address spaces that don’t consume resources, such as CICS or IMS transactions). The execution velocity is calculated as:

\[(100 * USING_CPU\%) / (USING_CPU\% + TOTAL_DELAY\%)
\]

These fields are described later. Low velocities indicate that the workload is experiencing a lot of delay. This may not be bad as long as the work is meeting its response or turnaround objectives. The actual velocities can be used to set velocity goals for a workload.

The most important field (I think!) on the report is the performance index, PERF INDX (PI). PI is re-calculated for each interval. A PI of 1.0 means that you’re exactly meeting your goal; a PI less than 1.0 means that the goal has been exceeded (the workload is achieving better response than requested); and a PI greater than 1.0 means that you’re missing the goal. It’s a wonderful single number to determine how you’re doing at meeting your goals. If I could only keep track of one indicator for a service class period, it would be the performance index. A sample report using just the performance index is shown in Figure 4. This is a plot of achieved PIs for different service classes. The PI value is on the y-axis and the time of day (hour) is on the x-axis. This allows you to compare how well different service classes are meeting their goals. With a horizontal bar indicating a PI of 1.0, anything above the bar indicates response goals that were missed.

We can see from this example that our importance values might be set incorrectly. Notice that TSO third period doesn’t meet its goals during peak periods, but test batch always meets or exceeds its goals. If TSO third period is more important than batch, you may have set the response goals incorrectly or batch might have a higher importance. Of course, it might not be your settings that are a problem. It could be that TSO third period needs a resource that test batch isn’t using. Sample PI calculations are shown in Figure 5.

The AVG ADRSP [CMF: AVG. # AS] field indicates the average number of address spaces in the period during this interval. You can see that the example in Figure 1 shows a large TSO site with at least 462 logged on TSO users (sum of all periods).

The USING CPU % [CMF: CPU USING] is the percent of samples (time) that this service class period was using the CPU, and is used in the execution velocity calculation.

The next section of the report, EXECUTION DELAYS %, shows the different delay and using states that the workload is experiencing. The Workload Manager looks at the same delay states to determine what may be
causing a particular service class period to be missing its goals. These numbers are useful on the RMF report because they provide some insight as to what delays the Workload Manager tried to address, and why a particular workload may have missed its goals. The TOTAL (CMF: TOTAL DLY) field is the sum of the following 10 fields. The execution delay fields are:

- CPU – A TCB or SRB is waiting to be dispatched or a TCB is waiting for a local lock.
- CAPP – CPU capping delay because a workload wanted to use the CPU but was delayed because a resource group maximum was being enforced.
- SWIN – Swap in delay (the swap has started, but not completed).
- MPL – MPL delay: this is equivalent to an out–and–ready condition where SRM has swapped a user out to control resources by reducing the MPL (allowable number of swapped in users).

**AUXILIARY PAGE DELAY % FROM** is divided into several reasons:

- PRIV – Waiting for page–in from page dataset for private page.
- COMM – Waiting for page–in from common or PLPA page dataset.
- XMEM – Waiting for page–in that occurred in an address space that was called cross memory from an address space in this service class period.
- VIO – Waiting for page–in for VIO page.
- SHSP – Waiting for page–in from page dataset for a standard hiperspace page that had been migrated or had been unable to be moved to expanded originally.
- EHSP – Estimated delay due to a miss on an ESO hiperspace page (this is WLM’s estimate of the I/O delay required due to a miss).

Portions of elapsed time of a job or transactions that aren’t included in the TOTAL DELAY % include OTHR, IDLE, and QUIE:

- OTHR – Unknown delay or time spent that can’t be affected by WLM and includes the following: a wait on ECB from another application, waiting on I/O (includes IOSQ time, but doesn’t include page delays), HSM, DB2 latches, enqueues, operator replies, JES2 delays, tape mounts (another flavor of wait on I/O), and long wait (WAIT macro with TYPE=LONG).
- IDLE – Percent of idle time. This includes any STIMER wait, TSO terminal input wait, TSO terminal output wait, APPC wait, or an initiator that is waiting for work. Notice that for TSO, the terminal input wait is the user think time, and will be quite large. See period one in Figure 1 with its 99.3 percent idle.
- QUIE: Job has been quiesced by operator with the RESET command, but it can be in one of the previous states as well as QUIE.

**Once you’ve set performance goals, the new performance index will help you easily see whether you’re meeting those goals. And once you’ve set response goals, you can use the delay reasons to identify the major WLM delays for the service class periods. This new data may be all the justification you need to move to goal mode as soon as possible.**

**RESPONSE TIME DISTRIBUTION**

If you specified an average response goal or a percentile response goal, the reports show you what the actual responses were. Although the report shows only four groupings, response distribution is kept in 14 buckets (fields) in the SMF record type 72, subtype 3. These buckets contain the number of transactions that completed within some amount of time compared to the goal response time. The fields correspond to the following:

<table>
<thead>
<tr>
<th>Bucket</th>
<th>Time Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>from 0 to 50 percent of goal</td>
</tr>
<tr>
<td>2</td>
<td>from over 50 percent to 60 percent of goal</td>
</tr>
<tr>
<td>3</td>
<td>from over 60 percent to 70 percent of goal</td>
</tr>
<tr>
<td>4</td>
<td>from over 70 percent to 80 percent of goal</td>
</tr>
<tr>
<td>5</td>
<td>from over 80 percent to 90 percent of goal</td>
</tr>
<tr>
<td>6</td>
<td>from over 90 percent to 100 percent of goal</td>
</tr>
<tr>
<td>7</td>
<td>from over 100 percent to 110 percent of goal</td>
</tr>
<tr>
<td>8</td>
<td>from over 110 percent to 120 percent of goal</td>
</tr>
<tr>
<td>9</td>
<td>from over 120 percent to 130 percent of goal</td>
</tr>
<tr>
<td>10</td>
<td>from over 130 percent to 140 percent of goal</td>
</tr>
<tr>
<td>11</td>
<td>from over 140 percent to 150 percent of goal</td>
</tr>
<tr>
<td>12</td>
<td>from over 150 percent to 200 percent of goal</td>
</tr>
<tr>
<td>13</td>
<td>from over 200 percent to 400 percent of goal</td>
</tr>
<tr>
<td>14</td>
<td>from over 400 percent of goal</td>
</tr>
</tbody>
</table>

In our example for TSO first period, the response goal was 90 percent within .5 seconds. The 14 buckets would contain the number of transactions that completed within:

- 1 – 0 to .250 seconds
- 2 – .250 to .300
- 3 – .300 to .350
- 4 – .350 to .400
- 5 – .400 to .450
- 6 – .450 to .500
- 7 – .500 to .550
- 8 – .550 to .600
- 9 – .600 to .650
- 10 – .650 to .700
- 11 – .700 to .750
- 12 – .750 to .800
- 13 – .800 to .850
- 14 – .850 to .900
- 15 – .900 to .950
- 16 – .950 to .999

After the execution delays portion of the workload activity report, the report program provides this response time distribution data by summarizing these 14 counters into four groups. You can find four lines of response times and buckets below the RESPONSE TIME DISTRIBUTION heading. The four buckets correspond to: those transactions that are less than or equal to half of the response goal (bucket 1), those that are between half the goal and the goal itself (buckets 2 to 6), those that are between the goal and twice the goal (buckets 7 to 12), and those that are over twice the goal (buckets 13 and 14).

The RESPONSE TIME corresponding to those categories is shown along with the number of transactions contained in the corresponding fields.

A running total is provided (under TOTAL) that shows the total number of transactions completing within that response time. The percents are located in the center. Looking at TSO period one, whose goal was 90 percent within .5 seconds, we find that 94.5 percent of the transactions completed in less than half the goal. Another 3.5 percent of the transactions completed between .25 and .5 seconds (or a total of 98.0 percent completing within the response goal). Notice that this percent was also listed in the ACTUALS line above.

A request for a velocity or discretionary goal provides an average response time (from the ACTUAL response time in the resource section), but doesn’t show distributions of response times. If you want the distributions, put in an easily met goal (e.g. 1 percent in less than 10 minutes) and then you’ll get the actual response time distributions. Don’t try this technique if you’re short on resources and this workload has to complete on time — stick with your velocity goal.
**SYSPLEX–WIDE REPORTS**

The information shown in Figures 1 and 2 in a sysplex environment can show multiple systems, depending on the control cards into the postprocessor. The default of both monitors is to produce a sysplex–wide report showing all systems in the sysplex, since the goals are for the entire sysplex. You could use selection parameters (SYSNAM) to report on a single system if you prefer.

CMF Monitor can produce a single view of multiple systems regardless of whether the systems are in a sysplex environment. Any SP 4 or SP 5 MVS system that’s connected via VTAM connections can produce a sysplex report showing data from multiple systems.

**MAKING THE MOVE**

As you can see, the new goal mode reports provide excellent new data to help you understand and monitor your data center. Once you’ve set performance goals, the new performance index will help you easily see whether you’re meeting those goals. And once you’ve set response goals, you can use the delay reasons to identify the major WLM delays for the service class periods. This new data may be all the justification you need to move to goal mode as soon as possible.

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