Collecting CPU MF (COUNTERS) on z/OS

With the System z10 GA2 there is a new hardware instrumentation facility, the “CPU Measurement Facility” (CPU MF) to assist with performance analysis. There is also a new z/OS component “Instrumentation”, or Hardware Instrumentation Services (HIS) to support the hardware instrumentation facility (CPU MF). Together these new capabilities can help identify any performance issues. In addition this analysis can be completed at and LPAR granularity level without the need for a POR.

There are 2 major capabilities of CPU MF, 1) Counters and 2) Sampling. **Counters** are used to count events for each CP such as Cycles used, Instructions, and cache events to compute information such as z10 cache hierarchy accesses to determine if performance issues exist. **Sampling** is used to take a snapshot of the CP information such as instruction address, primary address space number, and state information. This allows an analysis to map instruction addresses into modules or tasks and facilitates determination of hotspots.

For this z10 Performance Analysis we requesting you to run **COUNTERS** only mode.

In order to use the CPU MF and HIS, the following is requirements must be installed on your System z10 and z/OS operating systems

- **Requirements**: The z10 machine must be at GA2 Driver 76D – Bundle #20 or higher, (a z10 BC sub-capacity machine must be at Bundle #20 or higher also). and the z/OS LPAR being measured must be at z/OS 1.8 or higher with the PTFs for APARs OA25755, OA25750, and OA25773 applied. Also recommended is APAR OA27623 to add “CPU Speed” to the SMF 113 and to HIS COUNTERS output.

The purpose of this document is to provide instructions on the 4 Steps needed to enable CP MF and HIS, and collect the necessary information to send to IBM for analysis.

1. Step 1 – Configuring the System z10 Server to collect CPU Measurement Facility Data
2. Step 2 - Configuring z/OS to collect CPU Measurement Facility Data
3. Step 3 - Collecting CPU Measurement Facility Data (COUNTERS only)

At the bottom is also an Appendix Section which includes

- Questions

**Step 1 - Configuring the System z10 Server to collect CPU Measurement Facility Data:**
In order to collect CPU Measurement Facility Data on a z10 server, Driver D76D Bundle #11 or higher is required.

In the activation profile for the user’s LPAR, access the security tab and verify that ALL of the following settings are checked. For COUNTERS mode you only need to check Basic Counter, Problem State Counter, Crypto Activity Counter and Extended Counter within Counter Facility Security Options

Counter Facility Security Options
- Basic counter set authorization control
- Problem state counter set authorization control
- Crypto activity counter set authorization control
- Extended counter set authorization control
- Coprocessor group counter sets authorization control – Not Required for COUNTERS

Sampling Facility Security Options – NOT Required for COUNTERS
- Basic sampling authorization control
- Diagnosis sampling authorization control (This will only be seen if logged on to the SE in PEMODE)

Here is a sample of the screen:
If all the required settings are checked, proceed to activate the image. Otherwise, when the user attempts to start HIS Data Collection, the user will encounter an error message such as this one: “HIS026I MODIFY HIS COMMAND CANNOT BE PROCESSED. BASIC COUNTER SET IS UNAUTHORIZED.”

The diagnosis sampling option will only appear in PE mode.
You can also dynamically update the above security options from the HMC or on the SE via the Change LPAR Security icon if the LPAR(s) of interest is(are) already activated.

The Group Counter is not required, as it is currently not utilized by CPU MF. For example:

The diagnosis sampling option will only appear in PE mode.
Step 2 - Configuring z/OS to collect CPU Measurement Facility Data:

1. The z/OS operating system now provides access to CPU Measurement Facility data through Hardware Instrumentation Services (HIS). The user must have z/OS 1.8 or later with the PTFs for APARs OA25755, OA25750, and OA25773 installed. This APARs are required to use Hardware Instrumentation Services. PTFs are now available for all these APARs. This support requires an IPL with a CLPA. It is recommended that the customer always checks for additional service updates for HIS support.

2. If you don’t have a HIS member in SYS1.PROCLIB, copy the following procedure into the member, HIS, in your PROCLIB. This will be used to start Hardware Instrumentation Services (HIS). If you use ServerPac, the HIS procedure can be copied from ServerPac’s PROCLIB.

```plaintext
//HIS  PROC
//HIS  EXEC PGM=HISINIT,REGION=0K,TIME=NOLIMIT
//SYSPRINT DD SYSPUT=* 
//CMDFILE1 DD DUMMY
//CMDFILE2 DD DUMMY
```

3. Specify where to store the HIS output file:

   - Define a userid for the HIS started task with an OMVS segment that specifies
     - any UID based on your naming rules,
     - a default home directory for output files.
   For example, you might define the HIS user ID as follows:
   ```plaintext
   ADDUSER HIS OMVS(UID(123) HOME('/HIS'))
   ```
   where `uid(123)` is the OMVS uid and `/HIS` is the default home directory.
   (Note that while OMVS access is required, no special authorization is needed. Also, any directory can be used for the HOME directory.)

   - Create the `/HIS HOME` directory (in a local file system) by issuing the following “mkdir” command under OMVS:
   ```plaintext
   “mkdir /HIS”
   ```
   Then 1) assign read/write/exec authority to the `/user` directory by issuing:
   ```plaintext
   “chmod 777 /HIS”
   ```
   or 2) assign write authority to the `/HIS` directory via
   ```plaintext
   “chmod 660 /HIS”
   ```
   In this case, `/HIS` will be the default directory where the HIS output file will be stored. (Note that if you plan to capture lots of sample data, this
output directory for HIS data needs be large enough. For sample data, we recommend a directory with 1 GB available.)

4. Counter data can be captured in SMF records as well as in the *.CNT file. We are requesting SMF records (SMF 113):

- Start collecting SMF Type 113 records by adding 113 to the SYS statement and if necessary to the SUBSYS(STC(TYPE statements) in the SMFPRMxx member(s) for each LPAR for which data is being collected. SMF type 113, subtype 2 records are provided by the Hardware Instrumentation Services (HIS) support.

- Dynamically pick up the changes to the SMFPRMxx member(s) by issuing SET SMF=xx command on each LPAR of interest.

- Verify that the SMF type 113 records are being collected by issuing D SMF,O command on each LPAR of interest. Look for output similar to the ones below:

  ```
  SUBSYS(STC,TYPE(23,42,70:79,99:103,110,113)) -- PARMLIB
  ```

Step - 3 Collecting CPU Measurement Facility Data:

1. Issue the following z/OS Command to start the Hardware Instrumentation Services (HIS) Address Space:

   ```
   S HIS
   ```

   The following message indicates a successful start:

   **HIS002I HIS INITIALIZATION COMPLETE**

   If the correct Driver is not installed on the system, error message “HIS031I REQUESTED FUNCTION IS UNSUPPORTED BY HARDWARE” will be reported upon unsuccessful completion of the z/OS start HIS Address Space Command.

2. At the appropriate time during the measurement (which should take place during customer specific time(s)
Issue the following z/OS Command to start CPU Measurement Facility Data Collection. We recommend that the collection time interval be 24 hours for 2 days for COUNTERS mode. Using COUNTERS, CPU MF writes counters every 15 minutes from HIS once data collection starts. Also the OMVS file will also contain the delta of the counters regardless of the time interval. If you are running multiple z/OS LPARS (the major LPARS, we recommend that you run them for the same time period in parallel for COUNTERS mode, as this will provide both an LPAR view, along with a composite z10 resource view.

To start CPU Measurement Facility data collection for COUNTERS ONLY:

```
F HIS,B,TT='runid',PATH='/HIS/',CTRONLY,CTR=ALL
```

- The “CTRONLY” option indicates to HIS that ONLY Counters are to be collected.
- In this example, for CTR=ALL, will include 4 counters, (equivalent to CTR=(B,P,C,E) ), the “B” token indicates that the Basic counter set is to be collected; the “P” token indicates that the Problem counter set is to be collected; the “C” token indicates that the Crypto counter set is to be collected and the “E” token indicates that the Extended counter set is to be collected.

- For COUNTERS mode only measurements, the default duration is unlimited, so do not specify DUR.

Successful start of CPU Measurement Facility data collection is indicated by the following message:

```
HIS011I HIS DATA COLLECTION STARTED
```

Note: If any set up errors are encountered such as an option error, then, data collection can be stopped by issuing an “F HIS,E” command and restarting data collection with the correct options. To recover in some cases, it may be necessary to stop HIS (“STOP HIS”) and restart HIS (“S HIS”).

Note: For more information about collecting HIS data, please see the manual, z/OS V1R10.0 MVS System Commands, for details about using HIS commands.


3. At the end of the measurement, issue the following z/OS command to stop CPU Measurement Facility data collection:

```
F HIS,E
```
When the data collection Measurement ends, the system writes all the collected data to the UNIX System Services data set at the ‘/HIS’ path.

Successful stop is indicated by a message similar to the following:

```
HIS022I HIS DATA COLLECTION IS ENDING. 464
OUTPUT FILE PREFIX: SYSHIS20080413.223225
```

The file which contains the Counters will have a name whose format is similar to this: SYSHIS20080413.223225.CNT (For COUNTERS ONLY)

4. Save the SMF data  This data is required to reduce and analyze the data from the measurement. Note: Be sure to wait until data are written to the *.CNT file and the SMF MAXDORM value has expired before capturing the SMF 113 data.

For saving the SMF data, use the IFASMFDP utility to isolate SMF record type 113 and other records of interest. We also ask that you send the SMF 23s, 70s, 72s and 113s for the same time period as CPU MF COUNTERS was run (collecting SMF 113s).

5. Repeat steps 1-4 for each LPAR that requires the collection of CPU Measurement Facility data.

**Appendix**

**Questions**

Q: Can the z/OS HIS maintenance be applied to a non z10 GA2 machine, such as a z9 and HIS started on that processor?

A: Yes, it can be applied and all the z/OS HIS steps completed in advance, including starting HIS. What will happen is that HIS will issue the following message and then end.

```
$HASP373 HIS STARTED
IEF403I HIS - STARTED - TIME=21.09.36
HIS031I REQUESTED FUNCTION IS UNSUPPORTED BY HARDWARE
Jobname  Procstep Stepname  CPU Time      EXCPs     RC
HIS      STARTING HIS       00:00:00          5     00
IEF404I HIS - ENDED - TIME=21.09.36
```
Q: Does IBM need the Hardware Instrumentation Services address space to be started in order to use the Extended Counters Definition for the CPU Measurement Facility?

A: Yes - The HIS address space must be started in order collect Extended Counters data. However to collect information, data collection must be started, and that is accomplished with a Modify command to HIS via F HIS...(parms) to start data collection after HIS is running, and then a F HIS,E to stop data collection. There are several modes of Data Collection, but to get the Extended Counters, it is recommended to use "Counters Only" option.

Q: Is the HIS task something that we run on an on-demand basis, or all the time on every system? The Hold Data implies that we only run it as-needed. This is important, because I would prefer to avoid running the task everywhere.

A: Yes it is recommended to run on an On Demand. After successful testing, our initial view is that HIS should only be started and data collection done, when there is a specific reason for data collection.