

Collecting CPU MF (Counters) on z/OS

The purpose of this document is to describe the steps necessary to enable CPU MF Counters.

Background

With the System z10, z196 and z114 there is a new hardware instrumentation facility, the “CPU Measurement Facility” (CPU MF) which can help with workload characterization and performance analysis. There is also a new z/OS component “Instrumentation”, or Hardware Instrumentation Services (HIS) to support the hardware instrumentation facility (CPU MF).

There are 2 major modes for running CPU MF, 1) Counters and 2) Sampling. **Counters** mode is used to count events for each logical processor such as Cycles used, Instructions, and where data and instructions were sourced from the cache/memory hierarchy. (**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.) Note the two modes are mutually exclusive, and are determined by the various options of the Modify command. For this analysis we are requesting you to **run Counters mode only**.

Requirements

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 machine must be a z10, z196 or z114. z/OS should be at z/OS 1.10 or higher with APAR OA30486.

Enablement Steps

This section documents 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)

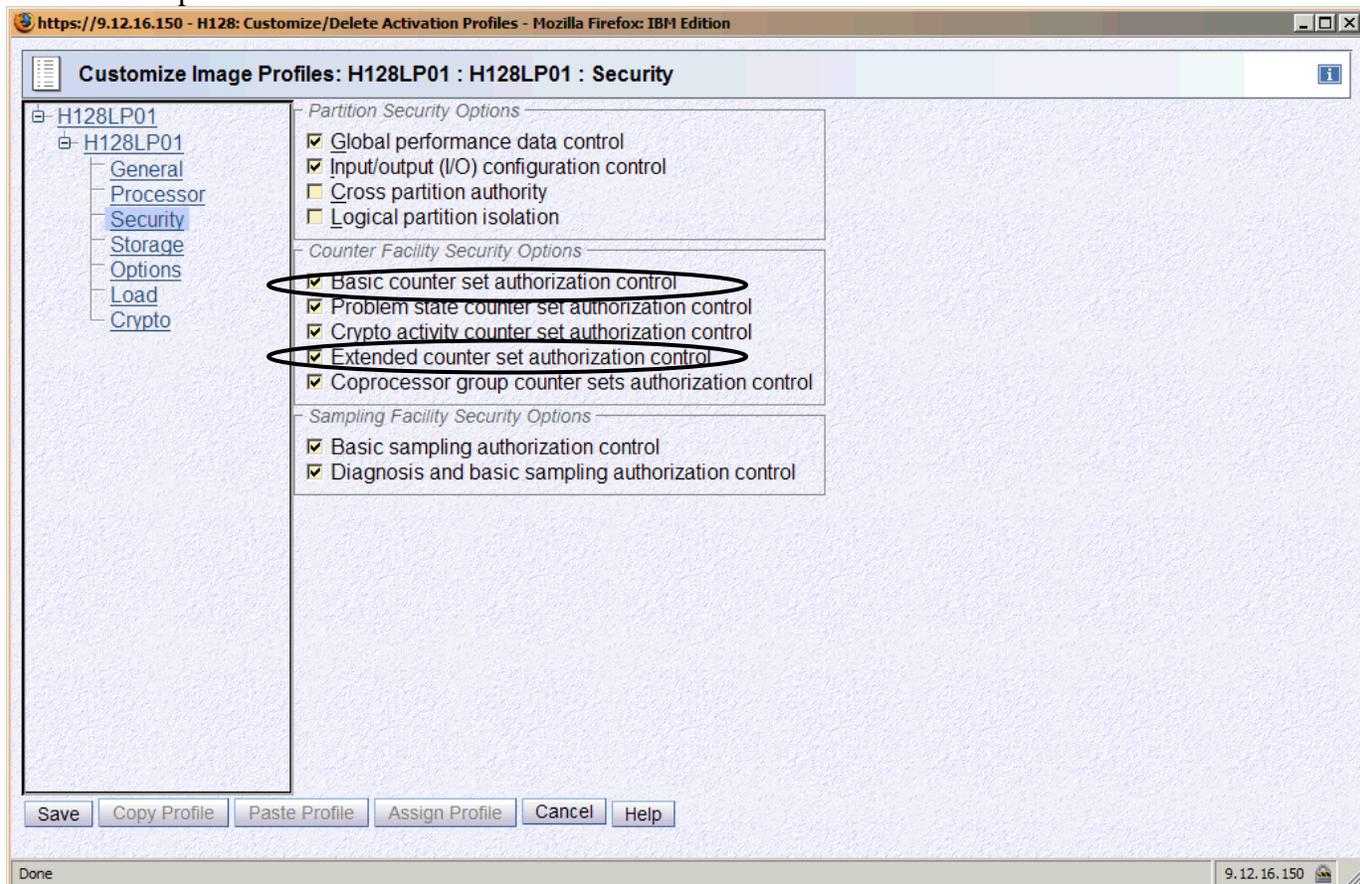
Step 1 - Configuring the processor to collect CPU Measurement Facility Counters Data:

In the activation profile for the user's LPAR, access the security tab and verify that the following settings are checked. For Counters mode one can check Basic Counter, Problem State Counter, Crypto Activity Counter and Extended Counter within *Counter Facility Security Options*. For this analysis we **only require Basic and Extended** to be checked (enabled).

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**

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”**.

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.

Change Logical Partition Security - H128

Input/output configuration data set (IOCDs): a0 H128BASE

Logical Partition	Active	Performance Data Control	Input/Output Configuration Control	Cross Partition Authority	Partition Isolation	Basic Counter	Problem State Counter	Crypto Activity Counter	Extended Counter	Group Counter	Basic Sampling	Diagnosis and Basic Sampling
H128CF1	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
H128CF2	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
H128LP01	Yes	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>						
H128LP02	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>						
H128LP03	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
H128LP04	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
H128LP05	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
H128LP06	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
H128USS	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
H128USS2	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
H12811	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
LP12	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
H12824	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
H12825	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
H12826	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
H12827	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
H12828	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
H12829	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
LP2A	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
LP21	No	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Buttons: Save and Change, Change Running System, Save to Profiles, Reset, Cancel, Help

Done 9.12.16.150

Step 2 - Configuring z/OS to collect CPU Measurement Facility Data:

1. The z/OS operating system provides access to CPU Measurement Facility data through Hardware Instrumentation Services (HIS). It is recommended to have z/OS 1.10 later with the PTFs for APAR OA30486 installed.
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.

```
//HIS PROC
//HIS EXEC PGM=HISINIT,REGION=0K,TIME=NOLIMIT
//SYSPRINT DD SYSOUT=*
//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:
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:
“mkdir /HIS”.

Then 1) assign read/write/exec authority to the /user directory by issuing: **“chmod 777 /HIS”** or 2) assign write authority to the /HIS directory via **“chmod 660 /HIS”**

In this case, **/HIS** will be the default directory where the HIS output file will be stored. (Even though Counters mode writes the data to SMF 113s records, this OMVS directory is still required. When HIS is finally stopped, it will write a very small amount of summary information into this directory, as a *.CNT file.

- Counters data can be captured in SMF 113s records as well as a summary in the *.CNT file. We are requesting these SMF records (SMF 113). You need to ensure that you are collecting these SMF records as specified in your SMFPRMxx member.

- 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:

```
SYS(TYPE(0,2,3,6:10,14,15,22:24,26,30,32,33,41,42,47:48,59,60:69,70:79,80:83,85,88,89,90:91,94,98,100:103,108,110,113,115:117,130,134,148:151,161,200,244,245)) – PARMLIB
```

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

Step - 3 Collecting CPU Measurement Facility Data:

- 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.

- Once HIS has been successfully started, issue the Modify command to start Counters and begin collecting SMF 113s.

Issue the following z/OS Command to start CPU Measurement Facility Data Collection. We recommend that CPU MF should be permanently enabled since it

requires so little space for the SMF 113 records and has very low overhead. Using Counters, CPU MF writes a SMF 113 every 15 minutes (as the default). Once the APAR installed above, you can optionally set the interval the SMF Global Sync value.) An OMVS file will be written once CPU MF Counters been ended. It is a very small amount of information.

To start CPU Measurement Facility data collection for **Counters ONLY**:
F HIS,B,TT='runid',PATH='/HIS',CTRONLY,CTR=(B,E),SI=SYNC

- The “**CTRONLY**” option indicates to HIS that ONLY Counters are to be collected.
- In this example, for **CTR=(B,E)**, will include 2 Counters, the “**B**” token indicates that the **B**asic counter set is to be collected, and the “**E**” token indicates that the **E**xtended counter set is to be collected. **SI=SYNC** sets the SMF Interval to “Synch” with the SMF Global recording interval of your system, so that SMF 113s are written at the same time and interval as other SMF records.

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

HIS011I HIS DATA COLLECTION STARTED

You can issue a Display HIS command to view the status and confirm the options

D HIS

Here is an example of the output from the Display HIS command where HIS had been modified with this specific command

```
F HIS,B,TT='BE Counters',PATH='/his',CTRONLY,CTR=(B,E),SI=SYNC
```

```
RESPONSE=SYSD  
HIS015I 10.15.54 DISPLAY HIS 286  
HIS 0025 ACTIVE  
COMMAND: MODIFY HIS,B,TT='BE Counters',PATH='/his',CTRONLY,CTR=(B,E),  
SI=SYNC  
START TIME: 2012/04/12 10:15:45  
END TIME: ---/--/-- --:--:--  
COMPLETION STATUS: -----  
FILE PREFIX: SYSHIS20120412.101545.  
COUNTER VERSION NUMBER 1: 1 COUNTER VERSION NUMBER 2: 2  
COMMAND PARAMETER VALUES USED:  
TITLE= BE Counters  
PATH= /his/  
COUNTER SET= BASIC, EXTENDED  
DURATION= NOLIMIT  
CTRONLY  
DATALOSS= IGNORE  
STATECHANGE= SAVE  
SMFINTVAL= SYNC
```

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.

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.
http://publibz.boulder.ibm.com/cgi-bin/bookmgr_OS390/BOOKS/IEA2G191/4.21.17?SHELF=EZ2ZO10L&DT=20081009045714

3. If you need to stop collecting CPU MF Counters, issue the following z/OS command to stop CPU Measurement Facility data collection:

F HIS,E

When the data collection measurement is ended for Counters, HIS writes a summary file to the UNIX System Services data set in 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)**

We recommend that once you’d enabled HIS and modified it to start data collection that you do not end it, and that you keep it collecting SMF 113s continuously.

Save the SMF data

Use the IFASMFDP utility to isolate the SMF 70s and 113s for the 4 hour time period from the system you want to FTP to IBM.

If you have any questions, send a note to John Burg, jpburg@us.ibm.com

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: 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.

A: Experience has shown that there is very little overhead and a very small amount of space is required for the SMF 113s records, so our recommendation is to enable CPU MF Counters on all of your production partitions and continuously run it and collect SMF 113s.

Q: Is the OMVS directory required for Counters mode?

A: Yes, even though CPU MF Counters writes SMF 113s records, the OMVS directory is still required, as summary information is written to it once Counters collection is ended.

z/OS Operational Considerations

As discussed above we recommend that HIS and CPU MF be continuously running and collecting SMF 113s. Many customers use “auto operations” to help ensure HIS is started and enabled correctly. Consider including the `START HIS` command in `COMMNDxx`, and in addition use the following z/OS system messages to trigger commands or actions in auto operations processes.

Condition: Once HIS is started, enable Counters and begin collecting SMF 113s

System Message: `HIS002I HIS INITIALIZATION COMPLETE`

Issue Command: `"F HIS,B,TT='runid',PATH='/HIS',CTRONLY,CTR=(B,E),SI=SYNC"`

Condition: HIS stopped recording data but HIS stayed active
System Message: **HIS025I** DATA COLLECTION IS PREMATURELY ENDING.
Action **Recycle HIS**