Intel® Management Mode Firmware Runtime Update – OS Interface

August 2021

Revision 1.00

Contents

Figures

Tables

Revision History

Revision Number	Description	Date
1.00	• Initial release	August 2021

1 Introduction

1.1 Background

Certain compute systems require high service level agreements (SLAs) where fewer system reboot firmware updates are required for deploying firmware changes to address bug fixes, security updates, and to debug and root cause issues. Intel's solution is called Intel® Seamless Update. The management mode (MM), UEFI runtime services and ACPI services handle most of the system runtime functions. Intel® processor architecture supports MM through System Management Mode (SMM). Changing the MM code execution during runtime is called MM Runtime Update (MRU).

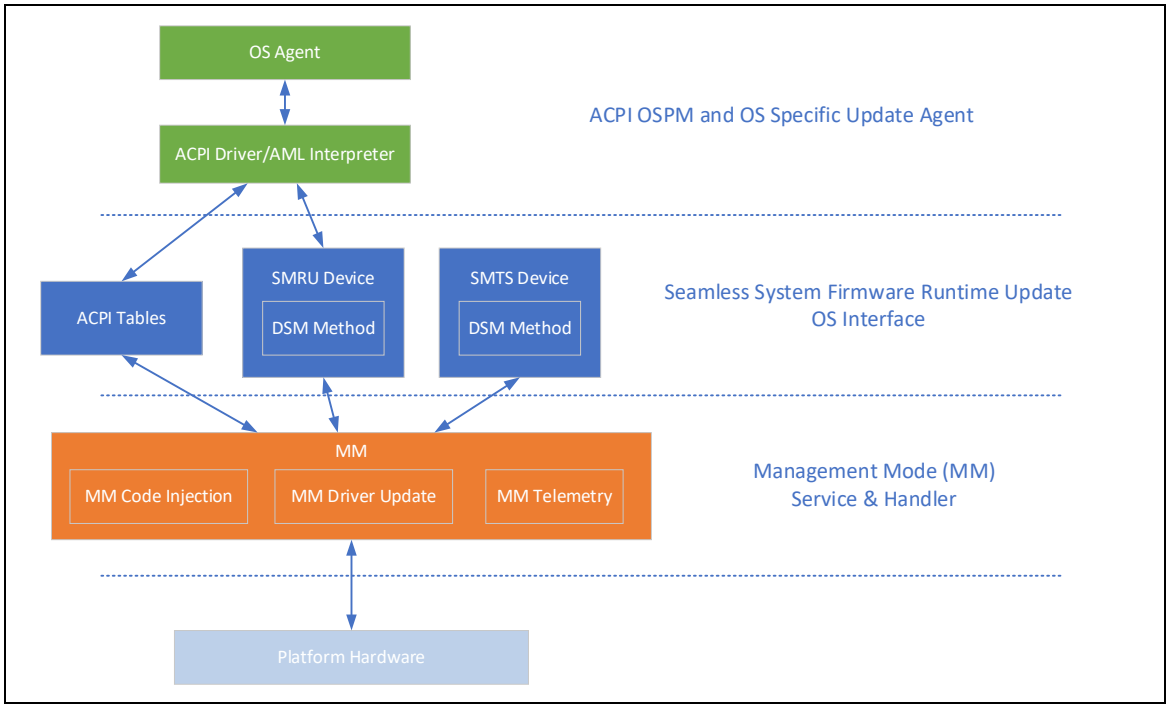
1.2 Overview

The MM Runtime Update mechanism incorporates the following features:

- MM Code Injection
- MM Driver Update
- MM Telemetry

These features are designed to be invoked from OS through ACPI Device Specific Method (DSM). The Figure 1-1 shows the high-level architecture of the MM runtime update infrastructure.

Figure 1-1. MM Runtime Update System



1.2.1 MM Code Injection

MM code injection feature provides a framework to deliver firmware image capsule to the MM that is designed to run in MM context for the given platform. The code update infrastructure allows delivering runtime firmware changes that are targeted for hardware and firmware state modifications to allow security or performance enhancements.

1.2.2 MM Driver Update

MM driver update feature provides a framework to deliver firmware image capsules to the MM that is designed to upgrade MM drivers. The driver update infrastructure allows delivering runtime firmware changes that are targeted for firmware driver changes to allow security or performance enhancements.

1.2.3 MM Telemetry

MM Telemetry feature provides a framework to retrieve log messages from MM for monitoring and root cause of issues.

1.3 Terminology

Table 1-1. Terminology

Term	Definition
ACPI	Advanced Configuration and Power Interface
BIOS	Basic Input/Output System
DSM	Device Specific Method
MM	Management Mode
OS	Operating System
SLA	Service Level Agreement
SMM	System Management Mode
MRU	MM Runtime Update
SMRU	Seamless MM Runtime Update
SMTS	Seamless MM Telemetry Service
UEFI	Unified Extensible Firmware Interface
UUID	Universally Unique Identifier

1.4 References

Table 1-2. Reference Documents

Reference	Document	Document Location
[UEFI]	UEFI Specification	https://uefi.org/specifications

2 ACPI DSM Interface

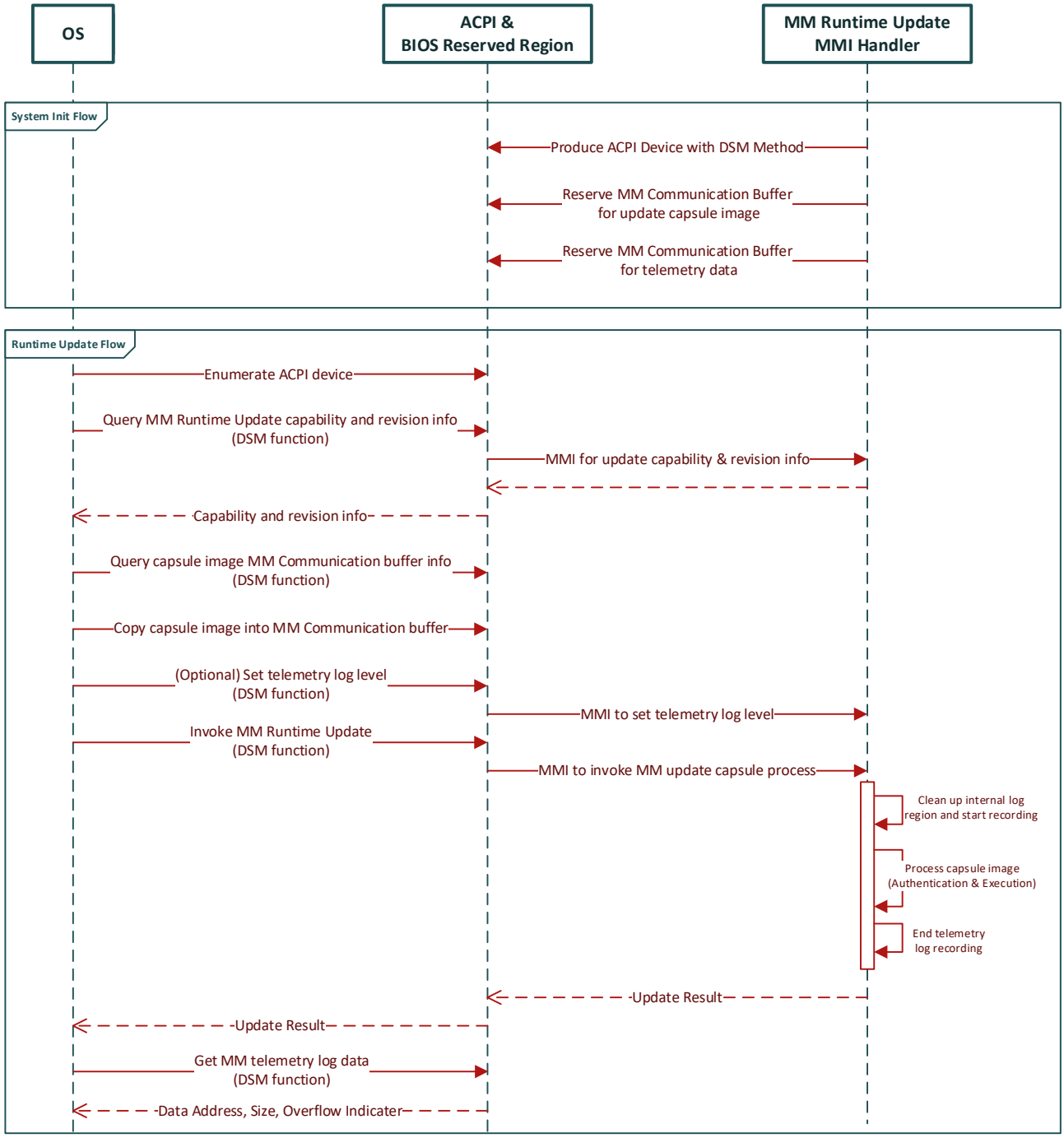
2.1 ACPI Interface Overview

A new ACPI namespace device is defined in this specification to facilitate the OS-BIOS communication of MM Runtime Update. Platforms that support MM Runtime Update must follow this specification to:

- Produce ACPI SMRU Device (Section 2.1) and required _DSM Method (Section 2.2.1).
- Provide an MM Communication Buffer for OS to deliver the MM Runtime Update Capsule Image to MM Runtime Update Handler.
- Provide MM Telemetry Service for OS to collect telemetry information during MM Runtime Update process.

An OS agent shall use the ACPI device DSM method defined in this specification to interact with platform BIOS to perform the MM Runtime Update. The MM Runtime Update workflow is shown in Figure 2-1. MM Runtime Update Flow Figure 2-1.

Figure 2-1. MM Runtime Update Flow



Note: An OS agent may repeat the “Runtime Update Flow” to deliver multiple MM Runtime Update capsule images to system firmware, or rollback a previous update in one power cycle.

2.2 MM Runtime Update

In order to handle MM Runtime Update, the OS must first be able to detect and enumerate the SMRU (Seamless MM Runtime Update) device. An SMRU device is represented by an ACPI namespace device with a _HID or _CID object value of "INTC1080".

An SMTS Device must contain the _DSM method required to program the MM Runtime Update as defined in Section 2.2.1.

Example:

```
Scope (\_SB) {
  Device (SMRU) {
    Name (_HID, "INTC1080")
    Name (_STR, ...)

    Method (_DSM, ...) {
      ...
    }
  }
}
```

2.2.1 _DSM Method

The _DSM method for an SMRU device is described in this section.

Input Parameters:

Arg0 – UUID (set to ECF9533B-4A3C-4E89-939E-C77112601C6D)

Arg1 – Revision ID (set to 1)

Arg2 – Function Index

Table 2-1. SMRU Device Function Index

Function Index	Description
0	Standard _DSM query function
1	Query Update Capability (see Section 2.2.3)
2	Query Communication Buffer Info (see Section 2.2.4)
3	Start MM Runtime Update (see Section 2.2.5)
All other value	Reserved

Arg3 – A package containing parameters for the function specified by the *UUID, Revision ID and Function Index*. The layout of the package for each command along with the corresponding output is illustrated in the respective *Function Index* description sections.

2.2.2 Return Status Values

If Function Index is not zero, the output package in this DSM may contain a Status field. The return status values are defined in next table.

Table 2-2. Return Status Values

Field Name	Description
Status	0 – Success 1 – Function Not Supported 2 – Invalid Input Parameters 3 – Hardware Error 4 – Retry Suggested 5 – Unknown Reason 6 – Function Specific Error (details in Extended Status field) All other value – Reserved
Extended Status	Function Specific

2.2.3 Function Index 1 – Query Update Capability

This function allows software to get the MM Runtime Update capability.

Function Input

None

Function Output

A package as described next.

```
Package {
        Status                                  //Integer
        Update Capability                       // Integer
        MM Code Injection Image Type            // Buffer
                MM Firmware Version             // Integer
                MM Code Injection Runtime Version  // Integer
        MM Driver Update Image Type             // Buffer
        MM Driver Update Runtime Version        // Integer
        MM Driver Update Runtime SVN            // Integer
        Platform ID                             // Buffer
        OEM ID                                  // Buffer
  OEM Information                               // Buffer
}
```

Table 2-3. Query Update Capability – Return Package Values

Field	Format	Description
Status	Integer	Defined in Table 2-2
Update Capability	Integer	Multiple bits can be set to indicate the supported MM Runtime Update features. A bit is set to one to indicate the feature is supported, zero means not supported. Bit 0 – MM Code Injection Bit 1 – MM Driver Update Others – Reserved and must be 0.
MM Code Injection Image Type	Buffer (16 Bytes)	A buffer containing an image type GUID. Platform supported capsule image type. The MM code injection capsule image must have the same *Update Image Type ID*.
MM Firmware Version	Integer	Platform MM firmware version. The supported firmware version value inside an MM Runtime Update Capsule image must have same value as this field.
MM Code Injection Runtime Version	Integer	MM Code injection runtime version for anti-rollback. An injected code image must have equal or higher image version than this value. This field is always initialized to 0 in the firmware boot. This field is invalid and must be ignored if MM Code Injection is not supported.
MM Driver Update Image Type	Buffer (16 Bytes)	A buffer containing an image type GUID. Platform supported MM Driver Update image type. The MM driver update capsule image must have the same *Update Image Type ID*.
MM Driver Update Runtime Version	Integer	The version of the SMI Driver Update runtime code. This field is invalid and must be ignored if MM Driver Update is not supported.
MM Driver Update Runtime SVN	Integer	The secure version number (SVN) of the SMI Driver Update Runtime code. The MM Driver Update Runtime Version of new capsule must be no less than the SVN in current BIOS. This field is invalid and must be ignored if MM Driver Update is not supported.
Platform ID	Buffer (16 Bytes)	A buffer containing a platform ID GUID. This is a platform specific GUID to specify the platform what this capsule image support. An MM driver update capsule image must have same *Platform ID*.
OEM ID	Buffer (16 Bytes)	A buffer containing an OEM ID GUID. This is a vendor specific GUID to specify the OEM ID. An MM driver update capsule image must have a same *OEM Header Type* with this value.
OEM Information	Buffer	A buffer containing the vendor specific information. This is a buffer object that contains the vendor specific data. OS shall check the OEM ID to determine how to interpret this OEM information data.

2.2.4 Function Index 2 – Query Communication Buffer Info

This function allows software to get the communication buffer information of MM Runtime Update.

Function Input

None

Function Output

A package as described next.

```
Package {
        Status                          // Integer
        Extended Status                 // Integer
        Buffer Address Low              // Integer
        Buffer Address High             // Integer
        Buffer Size                     // Integer
}
```

Table 2-4. Query Communication Buffer Info – Return Package Values

Field	Format	Description
Status	Integer	Defined in Table 2-2
Extended Status	Integer	Implementation specific
Buffer Address Low	Integer	Low 32-bit physical address of the communication buffer to hold an MM Runtime Update Package. **Note:** This field is not applicable to OOB MM Update.
Buffer Address High	Integer	High 32-bit physical address of the communication buffer to hold an MM Runtime Update Package. **Note:** This field is not applicable to OOB MM Update.
Buffer Size	Integer	Maximum size in bytes of the communication buffer.

2.2.5 Function Index 3 – Start MM Runtime Update

This function instructs the firmware to process the MM Runtime Update Capsule image in communication buffer.

Before invoking this function, an MM Runtime Update Capsule image must be placed in the communication buffer specified by Section 2.2.4.

If there is something wrong in the MM Runtime Update, it may be rolled back to the last known good version by issuing another call of this function, with a special capsule image or an older version capsule image.

Function Input

```
Package {
        Action                          // Integer
}
```

Table 2-5. Start MM Runtime Update – Input Package Values

Field	Format	Description
Action	Integer	Indicate what action is required to perform for the capsule image: 0 – Stage a capsule image from communication buffer into MM and perform authentication. 1 – Activate a previous staged capsule image. 2 – Perform both stage and activation actions.

Function Output

A package as described next.

```
Package {
        Status                          // Integer
        Extended Status                 // Integer
        Authentication Time   Low       // Integer
        Authentication Time   High      // Integer
        Execution Time Low              // Integer
        Execution Time High             // Integer
}
```

Table 2-6. Code Inject – Return Package Values

Field	Format	Description
Status	Integer	Defined in Table 2-2
Extended Status	Integer	Implementation specific
Authentication Time Low	Integer	Low 32-bit value of image authentication time in nanosecond.
Authentication Time High	Integer	High 32-bit value of image authentication time in nanosecond. A value of zero in Authentication Time Low and Authentication Time High means authentication time is not reported.
Execution Time Low	Integer	Low 32-bit value of image execution time in nanosecond.
Execution Time High	Integer	High 32-bit value of image execution time in nanosecond. A value of zero in Execution Time Low and Execution Time High means execution time is not reported.

Note that this function only measures the cryptographic authentication and image execution time of the MM runtime update image. The time of processor operating mode switching (entering/exiting MM) and SMI handler dispatching is excluded.

2.3 MM Telemetry

The OS must be able to detect and enumerate the SMTS (Seamless MM Telemetry Service) device to an SMTS device is represented by an ACPI namespace device with a _HID or _CID object value of “INTC1081”.

An SMTS Device must contain the _DSM method required to program the MM Runtime Update as defined in Section 2.3.1.

Example:

```
Scope (\_SB) {
  Device (SMTS) {
    Name (_HID, "INTC1081")
    Name (_STR, ...)

    Method (_DSM, ...) {
    ...
    }
  }
}
```

2.3.1 _DSM Method

The _DSM method for an SMTS device is described in this section.

Input Parameters:

Arg0 – UUID (set to 75191659-8178-4D9D-B88F-AC5E5E93E8BF)

Arg1 – Revision ID (set to 1)

Arg2 – Function Index

Table 2-7. SMTS Device Function Index

Function Index	Description
0	Standard _DSM query function
1	Set MM Log Level (refer to Section 2.3.3)
2	Get MM Log Level (refer to Section 2.3.4)
3	Get MM Log Data Info (refer to Section 2.3.5)
All other value	Reserved

Arg3 – A package containing parameters for the function specified by the *UUID, Revision ID and Function Index*. The layout of the package for each command along with the corresponding output is illustrated in the respective Function Index description sections.

2.3.2 Return Status Values

Same status code values are used as Section 2.2.2.

2.3.3 Function Index 1 – Set MM Log Level

This function allows software to set MM log level in MM Telemetry Service.

Log Level Definition:

0 – Error Message
1 – Warning Message
2 – Informational Message
4 – Verbose (Detailed message)

```
Function Input
Package {
        Log Level                   // Integer
}
```

Table 2-8. Set MM Log Level – Input Package Values

Field	Format	Description
Log Level	Integer	The MM telemetry log level to be set. Any log message with level equal to or less than Log Level (that is, of equal or higher priority) will be recorded by MM Telemetry Service. A log message with levels greater than Log Level will be discarded.

Function Output

A package as described next.

```
Package {
        Status                      // Integer
        Extended Status             // Integer
}
```

Table 2-9. Set MM Log Level – Return Package Values

Field	Format	Description
Status	Integer	Defined in Table 2-2
Extended Status	Integer	Implementation specific
Log Level	Integer	Configured log level value in MM Telemetry Service.

2.3.4 Function Index 2 – Get MM Log Level

This function allows software to get current MM log level from MM Telemetry Service.

Function Input

None

Function Output

A package as described next.

```
Package {
        Status                          // Integer
        Extended Status                 // Integer
        Log Level                       // Integer
}
```

Table 2-10. Get MM Log Level – Return Package Values

Field	Format	Description
Status	Integer	Defined in Table 2-2
Extended Status	Integer	Implementation specific
Log Level	Integer	Current log level in MM Telemetry Service.

2.3.5 Function Index 3 – Get MM Log Data Info

This function allows software to get MM Log Data from MM Telemetry Service. The function can return MM Runtime Update execution log data or history log data, depends on the data type value of the function input.

- Execution Log: MM execution log data generated since previous call of Start *MM Runtime Update* process (Section 2.2.5). The log data format is implementation specific like the BIOS serial log messages.
- History Information: MM Runtime update history information. The log data format is implementation specific like the BIOS serial log messages, but these log messages are not reset on *MM Runtime Update* process.

OS shall follow the Appendix A (OS Agent Sample Algorithm) described algorithm to retrieve delta MM Log Data with this function.

MM Log Data is generated by MM Runtime update driver, SMI handler or other MM modules, and consumed when this function is called. The detailed definition of the log entry format is out of scope and covered by MM Runtime Update – Telemetry Specification.

Function Input

DSM method Revision 1 doesn't support function input and always return Execution Log.

DSM method Revision 2 supports below function input:

```
Package {
        Data Type                       // Integer
}
```

Table 2-11. Get MM Log Data Info - Input Package Values

Field	Format	Description
Data Type	Integer	The MM telemetry log data type to get. 0 – Execution Log. 1 – History Information. Other value – Reserved.

Function Output

A package as described next.

```
Package {
        Status                          // Integer
        Extended Status                 // Integer
        Maximum Data Chunk Size         // Integer
        Data Chunk1 Address Low         // Integer
        Data Chunk1 Address High        // Integer
        Data Chunk1 Size                // Integer
        Data Chunk2 Address Low         // Integer
        Data Chunk2 Address High        // Integer
        Data Chunk2 Size                // Integer
        Rollover Count                  // Integer
        Telemetry Service Reset Count   // Integer
}
```

Table 2-12. Get MM Log Data – Return Package Values

Field	Format	Description
Status	Integer	Defined in Table 2-2
Extended Status	Integer	Implementation specific
Maximum Data Chunk Size	Integer	Maximum supported size of data of all Data Chunks combined
Data Chunk1 Address Low	Integer	Low 32-bit physical address of the telemetry data chunk1 starting address. **Note:** This field is not applicable to OOB MM Update.
Data Chunk1 Address High	Integer	High 32-bit physical address of the telemetry data chunk1 starting address. **Note:** This field is not applicable to OOB MM Update.
Data Chunk1 Size	Integer	Data size in bytes of the telemetry data chunk1 buffer. **Note:** This field is not applicable to OOB MM Update.
Data Chunk2 Address Low	Integer	Low 32-bit physical address of the telemetry data chunk2 starting address. **Note:** This field is not applicable to OOB MM Update.
Data Chunk2 Address High	Integer	High 32-bit physical address of the telemetry data chunk2 starting address. **Note:** This field is not applicable to OOB MM Update.
Data Chunk2 Size	Integer	Data size in bytes of the telemetry data chunk2 buffer. **Note:** This field is not applicable to OOB MM Update.
Rollover Count	Integer	Number of times MM telemetry data buffer is overwritten since telemetry buffer reset. Note: MM telemetry service uses a buffer to store telemetry data that has maximum capacity limitation. If data being logged reaches the maximum capacity, old telemetry data is overwritten by new one. This is called overflow condition.
Telemetry Service Reset Count	Integer	Number of times telemetry services resets that results in Rollover Count and Data Chunk buffers are reset

Note: Data Chunk2 Address shall be equal to Data Chunk1 Address + Data Chunk1 Size.

Use of Data Chunk1 and Data Chunk2 allows implementation flexibility for use of circular buffer and reduce merging overhead for the BIOS.

§

A Appendix (OS Agent Sample Algorithm)

This appendix provides sample algorithms for OS agent to retrieve MM Log Data.

A.1 Telemetry Buffer Data Retrieval

The following pseudo code outlines the OS agent algorithm for retrieving currently existing data from MM telemetry service. If the telemetry buffer gets full, most recent log data will overwrite old log data.

- Call ACPI DSM *Get MM Log Data Info* function
- Copy Data Chunk1 Size data starting from Data Chunk1 Address to OS owned destination storage
- Append Data Chunk2 Size data starting from Data Chunk2 Address to OS owned destination storage
- If Rollover Count is non-zero, overflow condition is occurred
- Call *Get MM Log Data Info* function again
- If data changed between *Get MM Log Data Info* calls, SMI had occurred and new Log Data was added during the processing. Repeat previous steps until data match

A.2 Delta Telemetry Data Retrieval

The following pseudo code outlines the OS agent algorithm for retrieving new MM Log Data since previous data retrieval:

First time access after system boot or on Telemetry Service Reset:

1. Follow the steps outlines Section A.1
2. Save the Get MM Log Data Info return data as previous parameters

Subsequent access (either polling or invoked again):

1. Call ACPI DSM Get MM Log Data Info function to determine the delta from delta starting parameters
2. If no parameter change
    - no new data present
3. Else If Rollover Count == previous Rollover Count && Telemetry Service Reset Count == previous Telemetry Service Reset Count
    - Data Start Address = previous Data Chunk2 Address + previous Data Chunk2 Size
    - Data Size = Data Chunk2 Size – previous Data Chunk2 Size
    - Copy data from Data Start Address of Data Size to destination storage
    - No data loss, indicate as no overflow condition

4. Else If Rollover Count == previous Rollover Count + 1 && Telemetry Service Reset Count == previous Telemetry Service Reset Count

- If Data Chunk2 Size <= previous Data Chunk2 Size (condition where new log data pointer has not moved past old log data pointer)
    - Data Start Address = previous Data Chunk2 Address + previous Data Chunk2 Size
    - Data Size = Maximum Data Chunk Size – Data Start Address
    - Copy data from Data Start Address of Data Size to destination storage
    - Data Start Address = Data Chunk2 Address
    - Data Size = Data Chunk2 Size
    - Append data from Data Start Address of Data Size to destination storage
    - No data loss, indicate as no overflow condition
- If Data Chunk2 Size > previous Data Chunk2 Size (condition where new log data pointer has not moved past old log data pointer)
    - Copy Data Chunk1 Size data starting from Data Chunk1 Address to destination storage
    - Append Data Chunk2 Size data starting from Data Chunk2 Address to destination storage
    - Data loss, indicate as overflow condition

5. Else If Rollover Count >= delta starting Rollover Count + 1 && Telemetry Service Reset Count == delta starting Telemetry Service Reset Count

- Copy Data Chunk1 Size data starting from Data Chunk1 Address to destination storage
- Append Data Chunk2 Size data starting from Data Chunk2 Address to destination storage
- Data loss, indicate as overflow condition

6. Else If Telemetry Service Reset Count != delta starting Telemetry Service Reset Count

- Data may have lost between telemetry service reset
- Go to “First time access after system boot or on Telemetry Service Reset” flow to start new delta log

7. Call ACPI DSM *Get MM Log Data Info* function again to check no data changed from previous call
8. If any Data Chunk Address, Data Chunk Size, Rollover Count or Telemetry Service Reset Count values changed between *Get MM Log Data Info* calls in step #1 and #7, SMI occurred and new Log Data is added during the processing. Go to step #1 to repeat the previous steps until data matches, or exit after several retries.
9. Save step #7 *Get MM Log Data Info* return data as new previous parameters