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Abstract

The Platform Management Components Intercommunication (PMCI) Working Group defines standards to address “inside the box” communication interfaces between the components of the platform management subsystem.

The group develops the Network Controller Sideband Interface (NC-SI), Management Component Transport Protocol (MCTP), Platform Level Data Model (PLDM), and the Security Protocol and Data Model (SPDM) specifications that provide a comprehensive, common architecture for improved communication between management subsystem components. These specifications enable the monitoring and control of systems independent of the OS state, when the OS is running or an OS is not available (for example, when a system is booting, before the OS has loaded, or when the OS is inoperable).

The PMCI Working Group creates intra-platform manageability standards and technologies, which complement DMTF’s inter-platform standards such as the Redfish API from the Redfish Forum, Common Information Model (CIM) profiles, as well as remote access protocols that are defined in the other DMTF groups.

Foreword

The *Platform Management Communications Infrastructure (PMCI) Architecture White Paper* (DSP2015) was prepared by the Platform Management Communications Infrastructure Working Group.

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Introduction

The Platform Management Communications Infrastructure (PMCI) Working Group defines standards to address “inside the box” communication interfaces between the components of the platform management subsystem.

This document lays forth the basic architectural concepts that are driving the specifications being defined by the PMCI working group (Note: This architecture is referred as PMCI architecture or PMCI herein). The focus of PMCI architecture is to enable intercommunications between different management components of a platform management subsystem in a standard manner across any implementation of a management component, independent of the operating system state.

Typographical conventions

The following typographical conventions are used in this document:

- Document titles are marked in *italics*.

Platform Management Communications Infrastructure (PMCI) Architecture White Paper

1 Scope

This white paper provides an overview of the PMCI workgroup and its goals, the PMCI architecture, and a high level summary of the primary specifications which it creates.

The intended target audience for this document is the readers interested in understanding management components intercommunications between the components of platform management subsystems. A platform management subsystem may be contained within servers, desktop systems, mobile systems, thin clients, bladed systems, and other types of devices.

This white paper is not a replacement for the individual PMCI specifications, but will provide an overview on how the specifications relate to each other within the PMCI stack model.

2 References

The following referenced documents are indispensable for the application of this document. For dated or versioned references, only the edition cited (including any corrigenda or DMTF update versions) applies. For references without a date or version, the latest published edition of the referenced document (including any corrigenda or DMTF update versions) applies.

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3 Terms and definitions

For the purposes of this document, the following terms and definitions apply:

3.1
Management Controller

An intelligent entity composed of hardware/firmware/software that resides within a platform and is responsible for some or all of the management functions associated with the platform; also known as BMC and Service Processor.

3.2
Managed Device

A device that is typically implemented using a microcontroller and accessed through a messaging protocol and is used for accessing one or more management parameters. Management parameter access provided by a managed device is typically accomplished using an abstracted interface and data model rather than through direct "register level" accesses. A managed device responds to management requests, but does not initiate or aggregate management operations except in conjunction with a management controller (that is, it is a satellite device that is subsidiary to one or more management controllers).

3.3
Management Parameter

A particular datum representing a characteristic, capability, status, or control point associated with a managed entity. Example management parameters include temperature, speed, voltage, on/off, link state, uncorrectable error count, device power state, and so on.

3.4
Network Controller

A managed device within a system that is responsible for providing connectivity to an external network world.

3.5
Network Controller Sideband Interface

The interface of the Network Controller that provides network pass-through and/or a control path to a Management Controller; also shown as Sideband Interface or NC-SI as appropriate in the context.

3.6
Platform Management Components Intercommunication

The Platform Management Components Intercommunication (PMCI) Working Group defines standards to address “inside the box” communication interfaces between the components of the platform management subsystem.

4 Symbols and abbreviated terms

The following abbreviations are used in this document.

4.1
CCI
Component Command Interface

4.2
CXL™
Compute Express Link

4.3 Management Controller
MC
Management Controller

4.4
MCTP
Management Component Transport Protocol

4.5
MD
Managed Device

4.6
NC
Network Controller

4.7
NC-SI
Network Controller Sideband Interface

4.8
NVME-MI™
NVM Express® Management Interface

4.9
PCIe®
Peripheral Component Interconnect Express

4.10
PLDM
Platform Level Data Model

4.11
PMCI
Platform Management Communications Infrastructure

4.12
RBT
RMII-Based Transport

4.13
RDE
Redfish Device Enablement

4.14
RMII
Reduced Media Independent Interface

4.15
SPDM
Security Protocol and Data Model

5 Platform Management Subsystem Architecture Overview

A Platform Management Subsystem in today's enterprise computing platforms is comprised of a set of components which communicate to perform management functions within the platform. In many cases, these communications and interfaces are specialized and adapted to each individual platform, installation and component in the environment.

A platform management subsystem provides hardware management services such as platform environmental monitoring functions (for example, temperature probing, voltage monitoring, fan speeds, hardware error status, etc.), control functions (for example, platform power-on/off, reset, watchdog timer, etc.), device firmware update and device functional management. The platform management subsystem frequently includes one or more intelligent controllers (microcontrollers) that support access to the management monitoring and control functions, which provide monitoring and control services for access by other management controllers in the subsystem. The platform management subsystem can be represented externally via the management controller through outward bound standards provided by other workgroups or forums within the DMTF. One example is the Redfish API that can be implemented as a service provider contained within the management controller which will enable a full end to end management approach. The use of the Redfish API standard for external connectivity, and a combination of MCTP, PLDM, NC-SI, and SPDM standards for internal communication provides for complete DMTF standards management of a Platform Management Subsystem.

PMCI supports a suite of specifications (MCTP, PLDM, NC-SI, and SPDM) which include architectural semantics, industry standard protocols, and platform level data models to standardize the management related intercommunications between the components of platform management subsystem independent of component implementation, platform state, and platform management subsystem implementation.

5.1 Principal Goals

One goal of PMCI is to enable intercommunications between different types of platform components using a set of standards protocols, interfaces, and platform level data models. An example of the platform management subsystem is provided in Section 5.2 to illustrate different types of components and intercommunications within a platform.

Another goal of PMCI is to enable the same semantics, protocols, and interfaces to work across a full range of platforms – traditional servers, desktop systems, mobile, laptop, bladed PCs as well as "thin clients".

5.2 Platform Management Subsystem Components

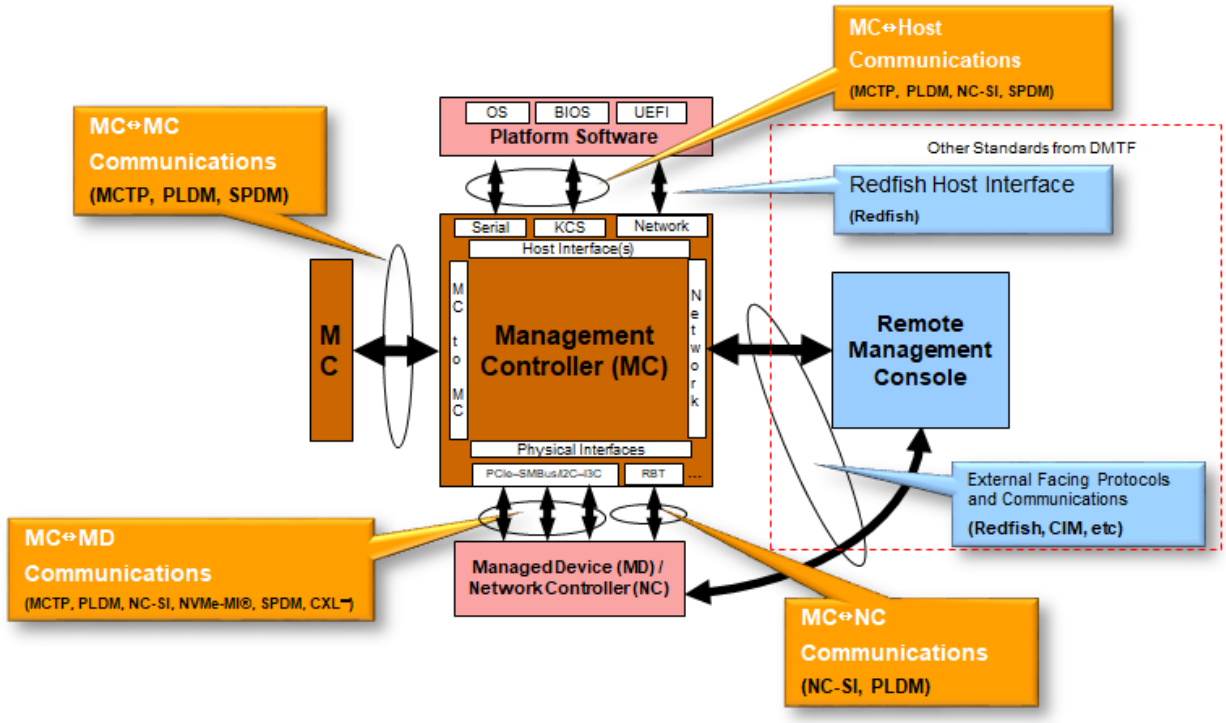

Figure 1 – Platform Management Subsystem

Figure 1 shows the different components within a platform management subsystem. The components can be divided into the following four categories:

1. Management Controller (MC): A microcontroller or processor that aggregates Management Parameters from one or more Managed Devices and Network Controllers and makes access to those parameters to local or remote software, or to other Management Controllers, via one or more management data models.
2. Platform Software: The software running on the host CPUs that communicates with a management controller for performing a set of management functions. The examples of the platform software may include BIOS, OS, UEFI firmware, etc.
3. Managed Device (MD) or Network Controller (NC): A Managed Device responds to management requests from the Management Controller, and can also initiate asynchronous messages, such as events, if enabled to by a Management Controller. A Network Controller is a managed device that additionally supports the NC-SI standard. A Network Controller may also provide connectivity to an external network.
4. Remote Management Console: is a function that enables communications with the management controller through one of more DMTF standards (for example the Redfish API or CIM). The remote console may initiate management queries or actions by sending requests to the MC which can use PMCI standards to communicate to Managed Devices or Network Controllers. The remote management console can also be located within the Platform Software and use MCTP Host Interface to communicate with the MC. Other DMTF standards such as Redfish Host Interface could also be used in the connectivity between the host and the MC.

PMCI covers all four types of intercommunications between the above components.

1. Management Controller and Host (platform software)

2. Management Controller and Managed Devices
3. Management Controller and Network Controller
4. Management Controller and another Management Controller or similar device

Other DMTF standards such as the Redfish API or CIM provide the external facing intercommunications between a management controller and a remote console or client.

6 PMCI Overview

6.1 Standards

The PMCI workgroup produces standards for four primary intercommunication interfaces/data models.

1) A family of specifications for a transport protocol known as Management Component Transport Protocol (MCTP). This protocol can be used to send messages between components of the platform management subsystem. Additional binding specifications are available for MCTP that permit the transport to operate over different physical mediums, which can support MCTP messages.
2) A family of specifications known as Platform Level Data Model (PLDM). These specifications define how individual management functions such as inventory, monitoring & control, eventing, firmware update, and Redfish device enablement (RDE) are abstracted and accessed by an MC.
3) The Network Controller Sideband Interface (NC-SI) specification defines how an MC can communicate to an NC for management functions such as inventory, external Ethernet pass-through to the MC, events, configuration, and statistics collection.
4) The Security Protocol and Data Model (SPDM) specification specifies a method for managed device authentication, firmware measurement, and retrieval of certificates.

6.2 PMCI Stack

Platform Management Communications Infrastructure (PMCI) Workgroup is defining a set of standards that can be used for communications between the platform components. A simplified view of the PMCI stack is show below as it organizes the standards into three primary groupings (upper layers, transport layer, and physical layer). This figure does not show the relationship or binding between each layer.

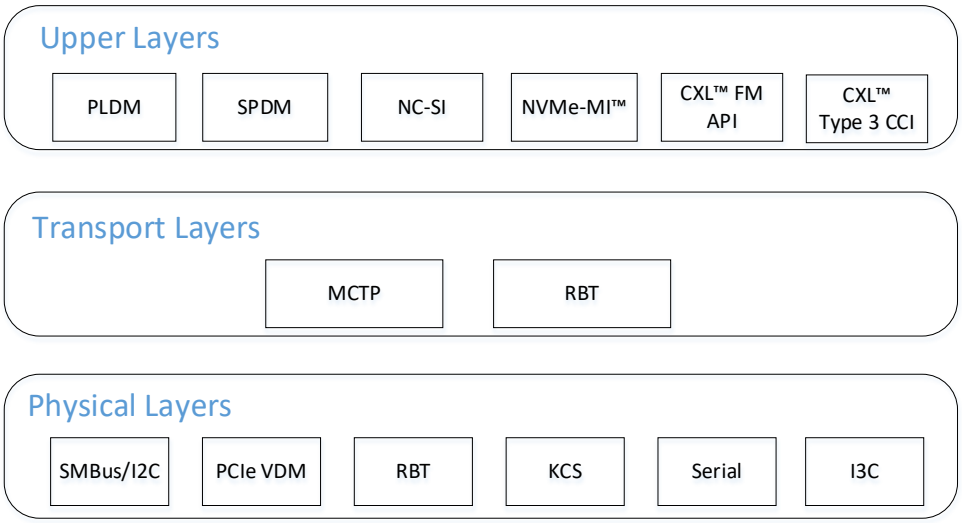

Figure 2 – Simplified view of the PMCI Stack

The following figure shows the full view of a PMCI stack, which includes the binding details.

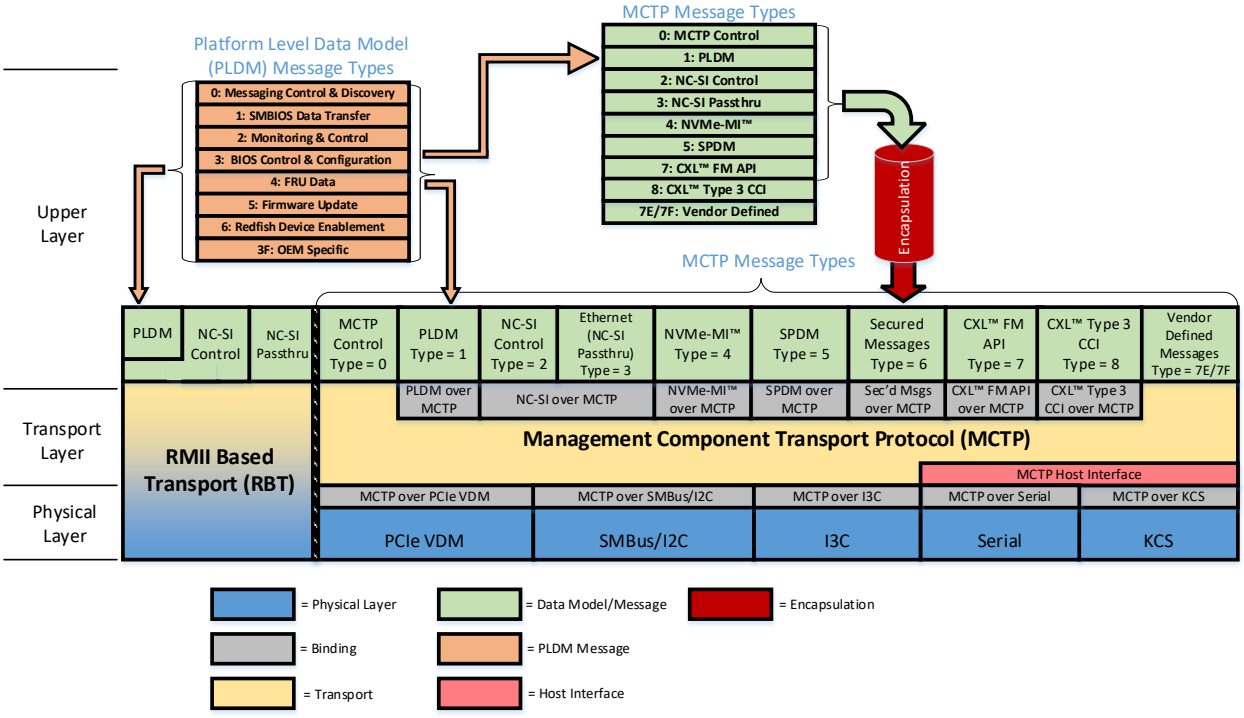

Figure 3 – Full PMCI Stack

In order to understand the full PMCI stack, each layer of the stack will be described in further detail in the next sections.

6.2.1 Physical Medium Layer

All of the PMCI standards and protocols are architected to be implemented on a physical medium. The diagram below represents the lowest portion of the PMCI stack and shows the five physical mediums that are currently supported. PMCI continues to expand the list of supported physical mediums, and additional binding specifications may be available in the future.

Figure 4 – Physical Medium Layer

The RMII-Based Transport (RBT) physical medium is the foundation for the NC-SI specification and is derived from the RMII specification. The electrical and timing requirements for an RBT interface is fully described within the NC-SI specification, and as its name implies also includes the transport details for sending and receiving messages. The RBT interface therefore is special within the PMCI stack as it is both a physical layer medium, and a transport layer combined.

The remainder of physical mediums shown in the figure above, represent available interconnects that the MCTP specification can be used with.

6.2.2 Transport Layer

There are two transports available from the PMCI Workgroup, RBT and MCTP. Each of these transports define a message passing protocol though there are differences between these two PMCI transports.

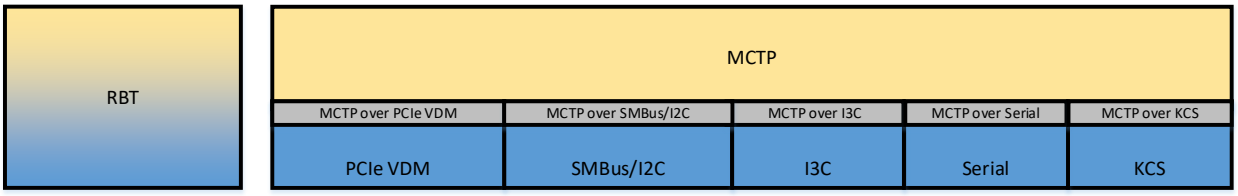

Figure 5 – Transport Layer

The RBT transport is a simple protocol used to track pass-through traffic and the reliable reception of command packets. Pass-through traffic consists of packets that are transferred between the external network interface and the Management Controller using the RBT interface. The transport protocol is based upon a command/response paradigm and involves the use of unique Instance IDs (IIDs) in the packet headers to allow responses received to be matched to previously transmitted commands. The Management Controller is the generator of command packets sent to the Sideband Interface of one or more Network Controllers in the system, and it receives response packets from them. Most but not all request messages sent over the RBT transport have a corresponding response message. An asynchronous event notification is one example of a packet sent by the Network Controller without a corresponding response message.

The MCTP transport can support both acknowledged (typically request/response) and unacknowledged messages (asynchronous). MCTP specifications include a grouping of documents known as binding

specifications, which define the necessary header and timing requirements for the transport to be used on the applicable physical mediums. Separate specifications are available for bindings to different physical media, such as MCTP over PCIe VDM Binding and MCTP over SMBus/I2C Binding. MCTP can also uniquely attach to interfaces used to communicate to/from a host system and its software (OS, UEFI, BIOS, etc.). As part of the MCTP set of specifications, there are two host interface specifications available, which define how MCTP can be supported over a serial or a keyboard controller style (KCS) interface.

6.2.3 Upper (Data Model) Layer

Sitting on top of the two PMCI transports are multiple choices for message definition and data models. MCTP provides a base control set of messages - and through additional binding specifications; PLDM, NC-SI, NVMe-MI™, SPDM, CXL™ FM API, and CXL™ Type 3 CCI messages.

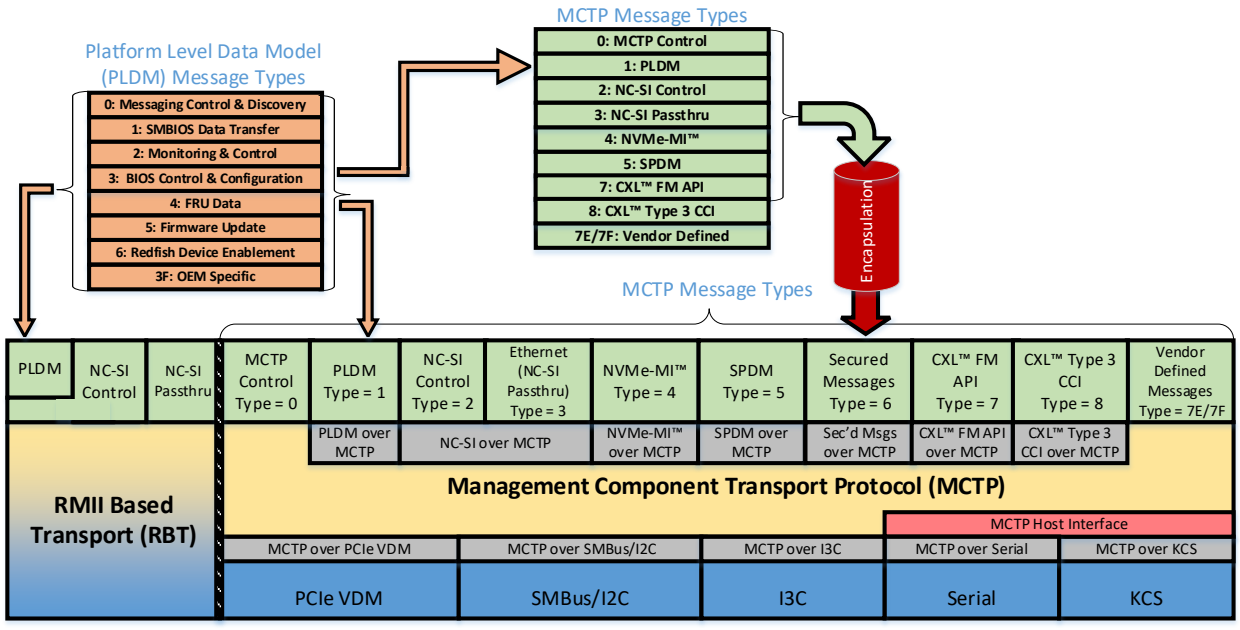

Figure 6 – Data Model Layer

The layers above MCTP define different communication and data models mapped over MCTP. The MCTP Control Protocol is used to set up and initialize managed devices within an MCTP network.

Platform Level Data Model (PLDM) provides efficient access to low-level platform monitoring, control, and data transfer functions such as temperature, fan, voltage, inventory data, event data transfer, and boot control. PLDM over MCTP defines data representations and commands that abstract the platform management hardware. More recent PLDM specifications have defined methods to perform a firmware update and support Redfish enablement on managed devices.

NC-SI defines a pass-through model of Ethernet communications between a management controller and a network controller.

SPDM defines a set of commands for authentication, firmware measurements, and certificate management.

6.2.4 Host Interface

MCTP provides a method for the host to communicate to the management controller through a physical layer host accessible interface. Both Serial and KCS have MCTP binding specifications, which permit host to management controller communications. A given management controller can optionally support one or both of the binding methods for host-based traffic.

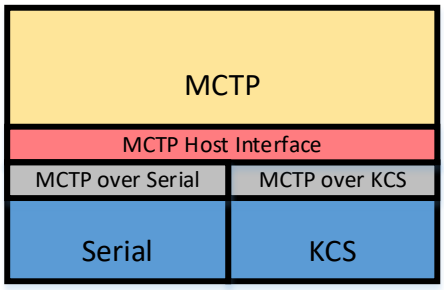

Figure 7 – MCTP Host Interface

7 PMCI Standards Overview

The PMCI standards are composed of technologies defined in a suite of standard specifications. These standards include the Management Component Transport Protocol (MCTP) related specifications, the Platform Level Data Model (PLDM) related specifications, the Network Controller Sideband Interface (NC-SI) specification, and the Security Protocols and Data Models (SPDM) specifications.

7.1 Management Component Transport Protocol (MCTP)

The Management Component Transport Protocol (MCTP) is a protocol for intercommunications among intelligent devices within a platform management subsystem. This protocol is independent of the underlying physical bus properties, as well as the "data-link" layer messaging used on the bus.

The physical and data-link layer methods for MCTP communication across a given medium are defined by companion "transport binding" specifications, such as MCTP over PCIe® Vendor Defined Messaging and MCTP over SMBus/I2C. This approach enables future transport bindings to be defined to support additional buses such as USB, and others, without affecting the base MCTP specification.

The MCTP communication model includes a message format, transport description, message exchange patterns, and operational Endpoint characteristics. MCTP uses logical addressing based on Endpoint IDs that enables static/dynamic endpoint ID assignments as well as bridging/routing support. MCTP defines simple message fragmentation/reassembly mechanism that allows large data transfers using MCTP packetization.

MCTP Control Protocol is used to setup/initialize MCTP control communications within an MCTP network. MCTP Control Protocol supports request/response, broadcast, and one-way communications.

The following specifications are available for MCTP:

- MCTP Base Specification – DSP0236
- MCTP PCIe VDM Transport Binding Specification – DSP0238
- MCTP SMBus/I2C Transport Binding Specification – DSP0237
- MCTP Serial Transport Binding Specification – DSP0253
- MCTP KCS Transport Binding Specification – DSP0254

- MCTP I3C Transport Binding Specification – DSP0233
- MCTP Host Interface Specification – DSP0256
- MCTP ID & Codes – DSP0239
- NVMe™ Management Messages over MCTP Binding Specification – DSP0235
- CXL™ Fabric Manager API over MCTP Binding Specification – DSP0234
- CXL™ Type 3 Device CCI over MCTP Binding Specification – DSP0281
- MCTP Overview White Paper – DSP2016

7.2 Platform Level Data Model (PLDM)

PLDM defines a method to provide efficient access to low-level inventory, monitoring, control, eventing, and data/parameters transfer functions such as temperature, fan, voltage, event logging, and boot control. Recent PLDM extensions enable device firmware updates as well as device management consistent with the DMTF Redfish standard.

7.2.1 PLDM Messaging types and applications

PLDM has defined data representations and commands that abstract the platform management hardware. Extensions of the core PLDM specification work includes:

1. Messages and data model for SMBIOS data transfer within the platform.
2. Messages and data structures for Field Replaceable Unit (FRU), asset information, and firmware inventory data transfer.
3. Messages and data structures for monitoring processors, caches, memory, sensors, fans, power state monitoring, time stamp clock monitoring, etc.
4. Control messages/data structures for sensors, fans, power state management, boot control, real time stamp, and watchdog timer.
5. Low level data models and messages to represent and transfer opaque data, BIOS data, and event data.
6. Messages to transfer text console redirection and media redirection related messages.
7. Data models and messages to facilitate device firmware management.
8. Messages and data models that enable management controllers to effectively interact with targeted devices using an encapsulated Redfish based JSON format.
9. Enablement of sending PLDM messages over the RBT transport which allows for managed devices with only the sideband RBT interface to communicate to an MC using PLDM.

The following specifications are available for PLDM:

- PLDM Base Specification – DSP0240
- PLDM over MCTP Binding Specification – DSP0241
- PLDM ID & Codes Specification – DSP0245
- PLDM State Set Specification – DSP0249
- PLDM for FRU Data Specification – DSP0257
- PLDM for SMBIOS Transfer Specification – DSP0246
- PLDM for BIOS Control and Configuration Specification – DSP0247
- PLDM for Platform Monitoring and Control Specification – DSP0248
- PLDM for Firmware Update Specification – DSP0267
- PLDM for Redfish Device Enablement Specification (RDE) – DSP0218
- PLDM NIC Modeling – DSP2054

7.3 Network Controller Sideband Interface (NC-SI)

The Network Controller Sideband Interface (NC-SI) specifies a Sideband Interface that uses RMII as a physical transport. NC-SI defines the formats for communicating network traffic, control commands, responses, and asynchronous event notifications between a management controller and a network

controller. NC-SI can support multiple Network Controllers through the use of hardware or command-based arbitration.

The following specifications are available for NC-SI:

- NC-SI Specification – DSP0222
- NC-SI over MCTP Binding Specification – DSP0261

7.4 Security Protocol and Data Model (SPDM)

The Security Protocol and Data Model (SPDM) specifies a method for managed device authentication, firmware measurement, and certificate retrieval. SPDM defines the formats for both request and response messages, which enable the end-to-end security features between the platform management components. SPDM also provides the ability to send secured messages through a generic record format used for encryption and message authentication of application data within SPDM's secure session. The following specifications are available for SPDM:

- Security Protocol and Data Model (SPDM) Specification – DSP0274
- Security Protocol and Data Model (SPDM) over MCTP Binding Specification – DSP0275
- Secured Messages using SPDM over MCTP Binding Specification – DSP0276
- Secured Messages using SPDM Specification – DSP0277
- Security Protocol and Data Model (SPDM) Architecture White Paper – DSP2058

8 Conclusion

PMCI supports a suite of specifications, which include architectural semantics, industry standard protocols, and platform level data models to standardize the management related intercommunications between the components of platform management subsystem independent of component implementation, platform state, and platform management subsystem implementation.

When used in conjunction with other DMTF standards for external facing communications, a complete end-to-end platform management subsystem can be developed for all management operations.

ANNEX A
(**informative**)

Change log

Version	Date	Description
2.1.0	2022-02-15	Updates to include the latest specifications & stack diagrams for PMCI architecture
2.0.0	2019-08-06	Updates to describe the latest architecture model available from PMCI.
1.0.0	2007-07-23	Initial Release

Bibliography

DMTF DSP4014, *DMTF Process for Working Bodies 2.10.0*,
https://www.dmtf.org/sites/default/files/standards/documents/DSP4014_2.10.0.pdf