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Theory on Platform Management Communications Infrastructure

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Abstract: Platform Management Communications Infrastructure (PMCI) Working Group develops standards for "inside the box" communication between platform management subsystem components. The Network Controller Sideband Interface (NCSI), Management Component Transport Protocol (MCTP), Platform Level Data Model (PLDM), and Security Protocol and Data Model (SPDM)are the standards that are developed by the PMCI group. These standards enable monitoring and control of systems regardless of the status of the operating system, whether it is running or not. This Paper Discusses how these four specifications effect on platform management subsystem.

Keywords: PMCI, NC-SI, MCTP, PLDM, SPDM, platform management subsystem.

I. INTRODUCTION

Distributed Management Task Force (DMTF) fabricates open standards for IT infrastructures like cloud, servers, network and storage. Alliance partners and Member companies like Broadcom Inc., Cisco, Dell Technologies, Hewlett Packard Enterprise, Intel Corporation, Lenovo, NetApp, Positivo Tecnologia S.A., and Verizon work together to improve the standards of inter-operable management of information technologies.

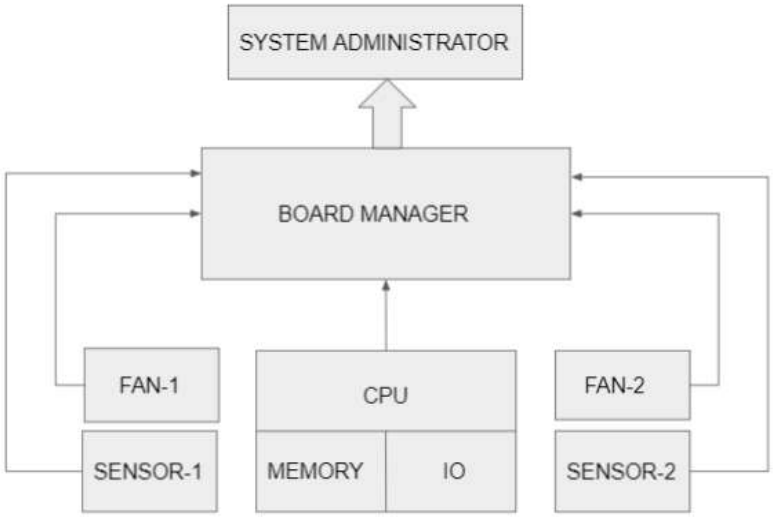

Fig 1: Platform Management Subsystem

Platform Management Subsystem gives the ability to keeptrack and report on the health of the system hardware through isolated software (or hardware) that does not depend on the operational state of the hardware. Platform management is very important for enterprise-class systems.The platform management hardware most cases resides on the same board as the system hardware. however, Since it is isolated it can remain functional even if the system hardware is non-operational. The platform management hardware is typically powered by a separate power supply. Servers constitutes the extensive numbers of these enterprise systems and they are the backbone of the Internet. When a server fails or is about to fail, it is crucial for the technical teams to find, investigate, fix, or replace the system quickly.

From figure 1 some sort of management system i.e, board manager manages the CPU's, memory, I/O, fans and sensors of a server and will report the same information to the system administrator. Here irrespective of the operation system or state of the server being monitored the board manager always keeps track of the health of the server through platform management subsystem.

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II. LITERATURE REVIEW

In [1], the detailed information about Distributed Management Task Force (DMTF) is explained and as well as introduction to the standards developed by DMTF and as well as standards which are still being developed by DMTF was explained. The DMTF contributors was also well versed.

In [2], Basics of platform management system was understood and the significance of platform management sub-system in different enterprise companies or their systems was learned. Different types of platform management and their installation techniques were learned.

In [3], detailed information about platform management communication infrastructure (PMCI) and its architecture was clearly explained.It also explains how well the PMCI standards that are developed by distributive management task force are being used in the managing platform subsytems.It also explained that these PMCI standards are used by different working groups.

In [4], detailed information about management control transport protocol (MCTP) that is developed by distributive management task force group. It also clearly explain its purpose in communicating between components in management subsytems. Message assembly, bridging and routing tables, SMBus Packet format were also discussed in detail.

In [5], detailed information behavior of the network controller sideband interface, which include its operational state sas well as the states of the associated components and the payloads and commands of the communication protocol supported over the interface.

In [6], detailed information on how messages, data structures, data objects are used to exchange between devices and physical media through security protocol data model (SPDM) was explained. Generic SPDM message format and different types of authentication was explained. Requirements for requesters and responders were also clearly explained.

In [7], a detailed introduction Platform management data model is given and also how this specification defines the base Platform Level Data Model (PLDM) for various platform functions, A common PLDM message format to support platform functions using PLDM was explained in detail.

In [8], detailed information on how an Intelligent platform management interface can be used to manage platform subsystem was discussed. It also explained why platform management protocols must be used in managing the subsystems. It describes the hardware and software framework for building a Management controller based on System on chip, in order to achieve cross-platform remote monitoring of IPMI management. The learnings from this paper will be used for future development of managing subsystems using PMCI models.
In [9], detailed information on how this specification defines functions & data structures used for discovering, describing, initializing and accessing sensors and effecters within the management controllers and management devices of a platform management subsystem using PLDM messaging.

III. PMCI

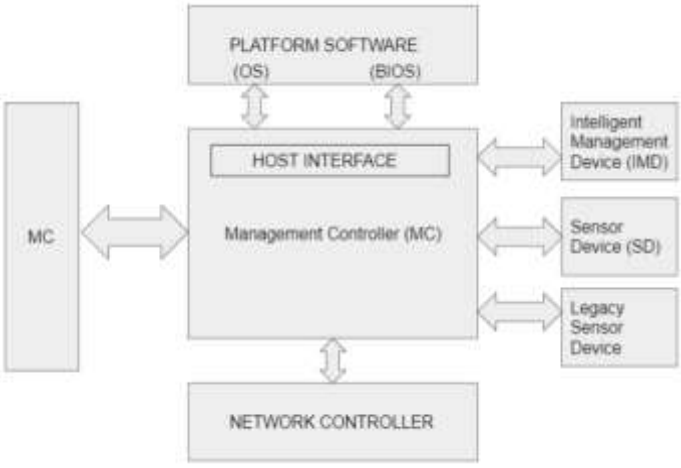

Fig 2: Image of PMCI components and intercommunications within a platform

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One of the PMCI's goals is to use a collection of standardised protocols, interfaces, and platform level data models to facilitate intercommunications across different types of platform components. Figure 2 illustrates different types of components and inter communications within a platform. PMCI's other purpose is to enable the same semantics, protocols, and interfaces to function across a wide range of platforms, including traditional desktop systems, mobile, laptop, and server computers.

A management controller is a microcontroller or processor that collects Management Parameters from one or more Management Devices and makes them accessible to local or remote application software, as well as other Management Controllers, using one or more management data models. Platform software is a piece of software that runs on the host CPUs and connects with a management controller to conduct a set of management tasks. BIOS, OS, and EFI firmware are all instances of platform software.Except in combination with a Management Controller, a Management Device listens to management requests but does not originate or aggregate management processes. A temperature sensor chip is an example of a basic Management Device. There are three main types of management devices: standard sensor device , which exposes a standard low-level interface, legacy sensor device, which uses a non-standardized register level low-level interface, and intelligent management device, which provides Management Parameter access typically via an abstracted interface and data model rather than via direct register level access. A network controller is a system component that is in charge of connecting to the outside world via a network.
PMCI helps in inter communicating between:

1. Management Controller and Host (platform software)
2. Management Controller and Management Devices
3. Management Controller and Network Controller
4. Management Controller and Management Controller

A. PMCI Stack

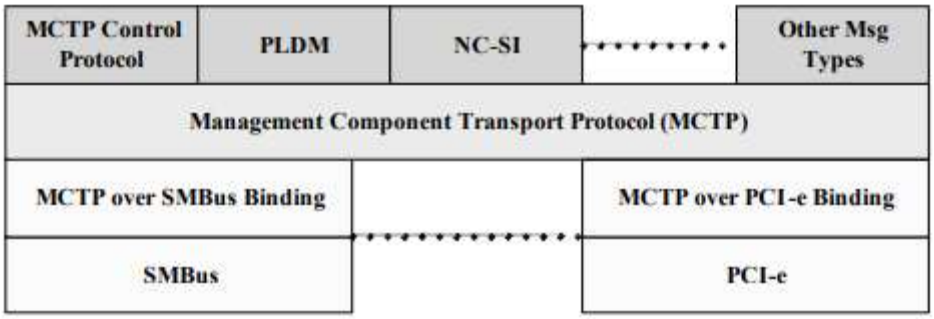

Fig 3: Image of PMCI Stack

The Management Component Transport Protocol is the heart of the PMCI stack (MCTP). MCTP is a protocol for ‘inside the box' platform management traffic communication. MCTP supports a variety of message kinds, including MCTP control, Platform level data model, Network pass-through, and so on. MCTP may be used with a variety of media types. The binding layer is the layer beneath MCTP that is utilised to bind MCTP to a specific physical medium. The bottom layer depicts several physical media. Different communication and data models are overlaid over MCTP by the layers above it. Within an MCTP network, the MCTP Control Protocol is used to initialize MCTP control communications. Temperature, fan, voltage, inventory data, event data transmission, and boot control are just a few of the low-level platform monitoring, control, and data transmission features that the Platform Level Data Model (PLDM) makes available. Data representations and instructions that abstract the platform management hardware are defined by PLDM over MCTP. A pass-through paradigm of communication between a management controller and a network controller is defined by NC-SI/MCTP.

IV. MCTP

The Management Component Transport Protocol (MCTP) is a protocol that allows intelligent devices in a platform management subsystem to communicate with one another. The underlying physical bus attributes, as well as the "data-link" layer communications utilised on the bus, are unaffected by this protocol. Companion "transport binding" definitions, such as MCTP over PCIe Vendor Defined Messaging and MCTP over SMBus/ IC, describe the physical and data-link layer mechanisms for MCTP communication across a specified medium. Future transport bindings may be written in this way to support other buses like USB, RMII, and others without altering the main MCTP standard.

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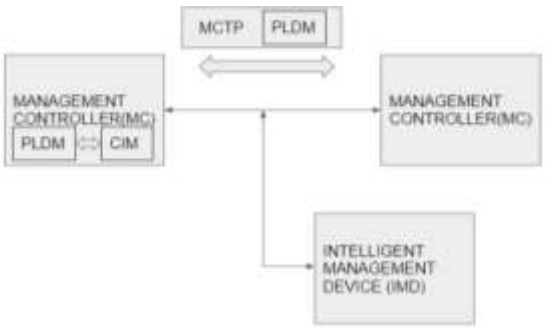

Fig 4: MCTP Overview

Figure 4 demonstrates where exactly MCTP is being used in the platform management subsystem. A message format, transport description, message exchange patterns, and operational Endpoint characteristics are all part of the MCTP communication paradigm. MCTP employs logical addressing based on Endpoint IDs to handle both static and dynamic endpoint ID assignments as well as bridging and routing. MCTP specifies a simple message fragmentation/reassembly methodology that enables huge data transfers to be carried out utilising MCTP packetization. Within an MCTP network, the MCTP Control Protocol is used to set up/initialize MCTP control communications. Request and response, broadcast, and one-way communications are all supported by the MCTP Control Protocol.

V. PLDM

Platform level data model (PLDM) defines data representations and commands that abstract the platform management hardware. An effective interface and data model that provides efficient access to Low-level platform inventory, BIOS control and configuration data. Platform monitoring and control functions, alerting and event log data.... PLDM Defines data representations and commands that abstract platform management subsystem components. It Provides transport independent Request/Response Style Messaging Model. It Allows messages to be grouped based on the functions. Allows the discovery of the functionality supported. There are 7 types of PLDM specifications and are listed in the following table.

TABLE I PLDM SPECIFICATIONS

PLDM Specification Type	Description
PLDM Messaging Control and Discovery type-0	PLDM Messages that are used to support communication control and discovery operations for PLDM
PLDM for SMBIOS type-1	PLDM Messages that are used to support SMBIOS data Transfer.
PLDM for Platform Monitoring & Control type-2	PLDM Messages that are used to support platform monitoring and control.
PLDM for BIOS Control and Configuration type-3	PLDM Messages that is used to support BIOS control & configuration data transfer between the BIOS & MC
PLDM for FRU Data type-4	PLDM Messages that are used to support FRU data exchange
PLDM for firmware update type-5	Defines messages & data structures for updating firmware or other objects associated with firmware device of a platform management subsystem
PLDM for Redfish device enablement type-6	This specification allows a MC to deliver Redfish standards of management of IO adapters in a server without the need for code specific to each adapter

VI. NC-SI

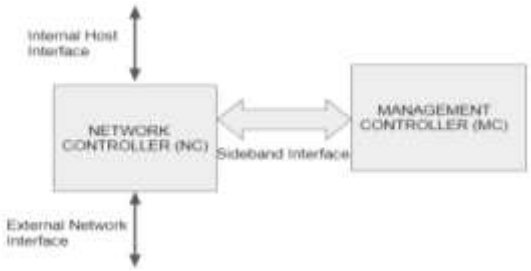

Fig 5: NC-SI functional block diagram

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The Distributed Management Task Force has established an electrical interface and protocol known as NC-SI (network controller sideband interface) (DMTF). Typically the link between the out-of-band Management Controller and the Network Controller is crucial in out-of-band management setups. This interface is in charge of facilitating communication between the Management Controller and third-party management software. There are now various proprietary interfaces in use in the industry, resulting in discrepancies in out-of-band management implementation. The purpose of this standard is to provide an interoperable sideband communication interface standard that will allow management data to be exchanged between the Management Controller and the Network Controller.The Sideband Interface is designed to give the Management Controller network access, and the Management Controller is supposed to handle all network activities.

From Figure 5 it is understood that NC-SI is a interface that is between a Management controller and one or more network controllers. This interface in figure 5 is called as a Sideband Interface and is responsible for allowing external network connectivity for the Management Controller while also enabling the external network interface to be shared with traffic to and from the host.

The topologies supported under this standard apply in such a way that a single Management Controller is actively communicating with one or more Network Controllers on the NC-SI. Below layouts explain the above statement.

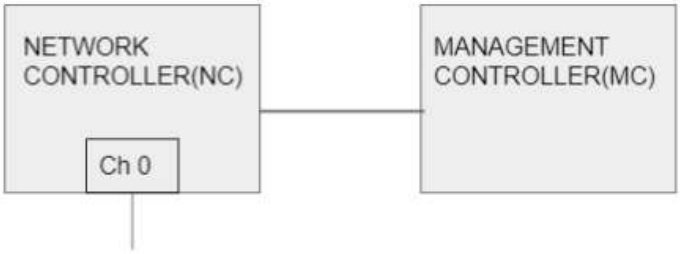

Fig 6: layout 1: Single Channel, Single Package

In figure 6, Layout 1 shows a Management Controller connecting to a single Network Controller with a single external network connection.

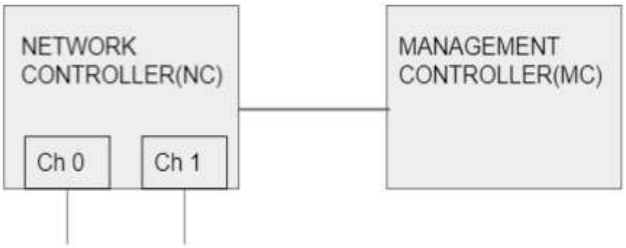

Fig 7: layout 2: Dual Channel, Single Package

In figure 7, Layout 2 shows a Management Controller connecting to a Network Controller package that supports two NC-SI channels connections.

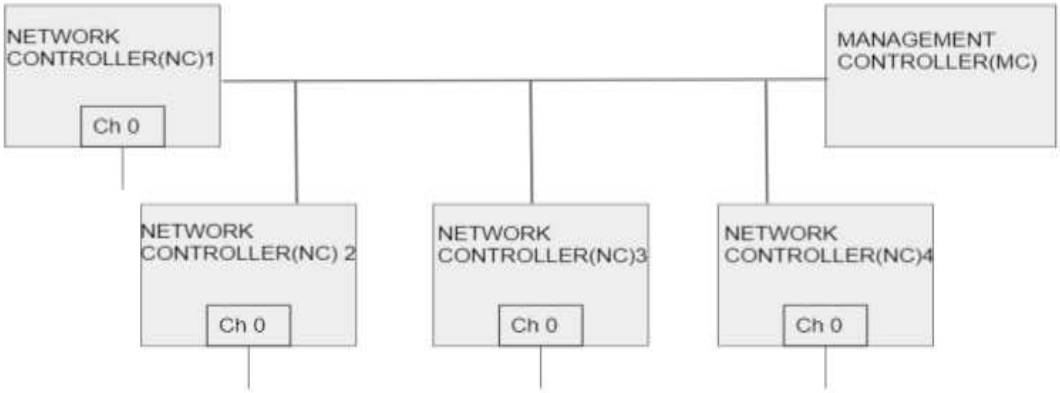

Fig 8: layout 3: Single Channel, Four Different Packages

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In figure 8, Layout 3 shows a Management Controller connecting to four discrete Network Controllers of single channel.

VII. SPDM

The Security Protocol and Data Model (SPDM) Specification specifies messages, data objects, and sequences for exchanging communications between devices through various transport and physical media. Authentication of hardware IDs and firmware identity measurement are included in the description of message exchanges. The SPDM allows for quick and easy access to low-level security functions. The message exchanges specified in this specification are conducted and exchanged between two endpoints and are conducted and exchanged using SPDM messages described in SPDM messages. The SPDM message exchanges are described in a general manner, allowing messages to be transmitted through a variety of physical media and transport protocols.

The two endpoints play the roles of Requester and Responder. All communications are sent in a command/response format, with the Requester beginning contact and the Responder responding.
Endpoints can support both Requester and Responder functionality. A pair of endpoints can be participating in two SPDM message streams amongst themselves, with each endpoint having a Requester and a Responder role. These two streams are incompatible.
The message exchanges defined in this specification include:

1. Security capability discovery and negotiation of a responder
2. Identity Authentication of a Responder.
3. Retrieve the firmware measurement of a Responder.

A. Security capability discovery and negotiation: This standard establishes a method for a Requester to learn about a Responder's security capabilities. An endpoint might, for example, implement several cryptographic hash functions described in this standard. Furthermore, if an overlapping set of cryptographic algorithms is supported by both endpoints, the standard describes a mechanism for a Requester and Responder to select a common set of cryptographic algorithms to be used for all subsequent message exchanges before another negotiation is initiated by the Requester.

B. Identity Authentication: The validity i.e, authenticity of a Responder is determined in this standard using digital signatures utilising well-established public key cryptography methods. A Responder establishes its identity by creating digital signatures with a private key, which the Requester may verify cryptographically using the public key associated with that private key.

C. Firmware and configuration measurement: The act of computing the cryptographic hash value of a piece of firmware/software or configuration data and associating the cryptographic hash value to the endpoint identification using digital signatures is referred to as measurement. This allows an authentication initiator to verify the identification and measurement of the endpoint's firmware/software or configuration.

D. SPDM Messaging Protocol: Security protocol and data model messaging protocol establishes a request-response messaging paradigm between two endpoints in order to carry out the SPDM message exchanges. An SPDM response message must be sent in response to each SPDM request message.Figure 9 shows request response flowchart diagram for SPDM.

Fig 9: SPDM Messaging Protocol

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VIII. CONCLUSION

The PMCI standard addresses inside-the-box communication and functional interfaces between platform management subsystem components. The PMCI standards and technologies complement the DMTF CIM profiles and remote access protocols specified by other DMTF working groups such the Desktop and Mobile Work Group (DMWG), Server Management Work Group (SMWG), and WBEM Infrastructure Protocols (WIP).

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