S-RFUP: Secure Remote Firmware Update Protocol

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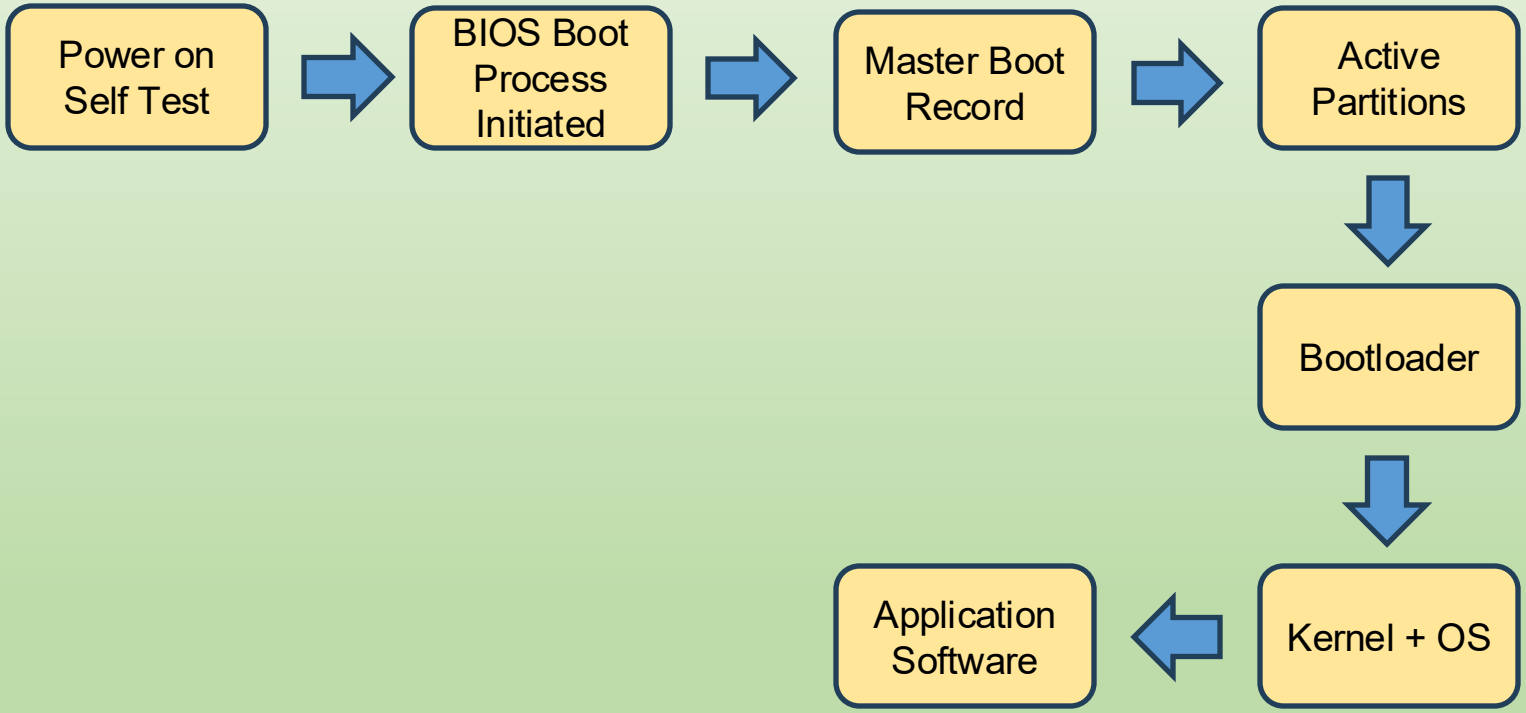
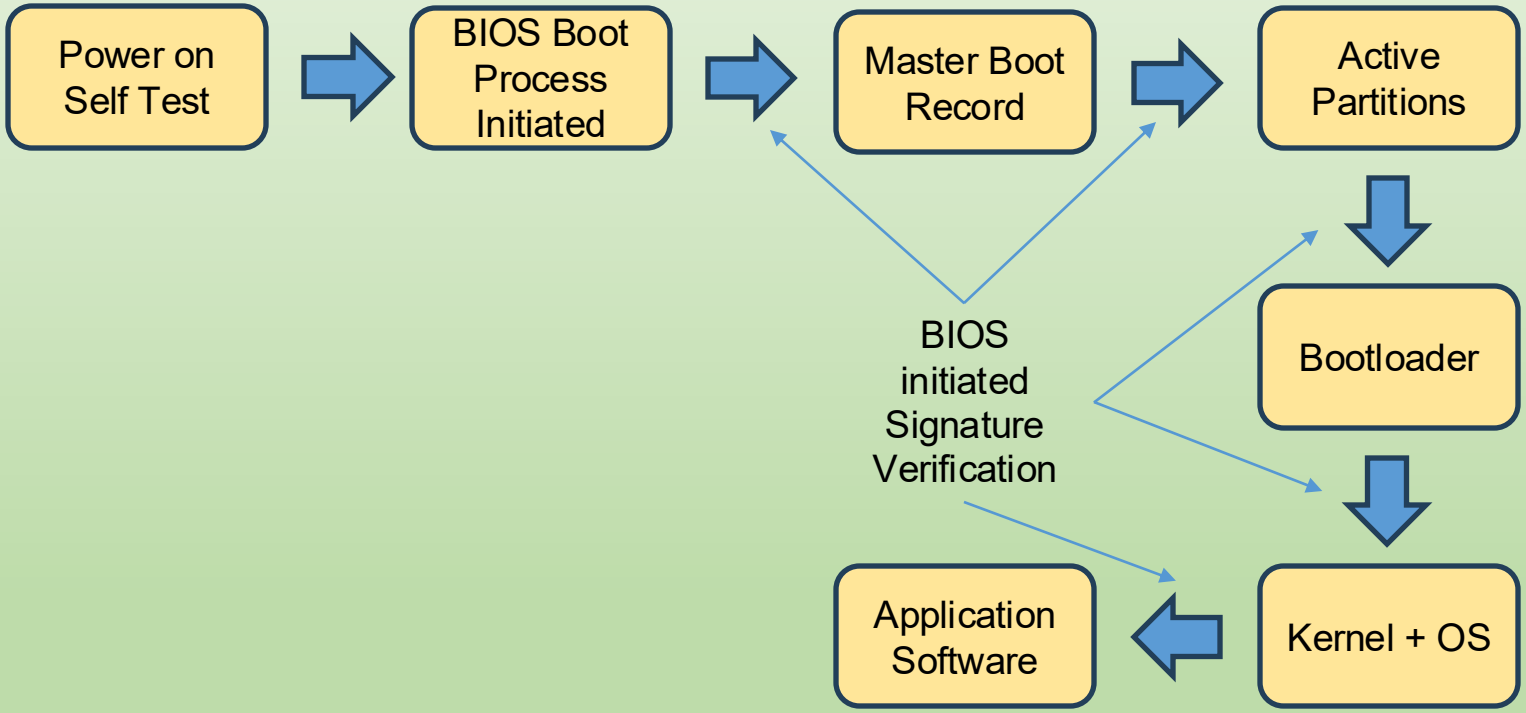
Background – Conventional Device Boot Process (Simplified Version)



Background – Secure Boot Process with Code Signing



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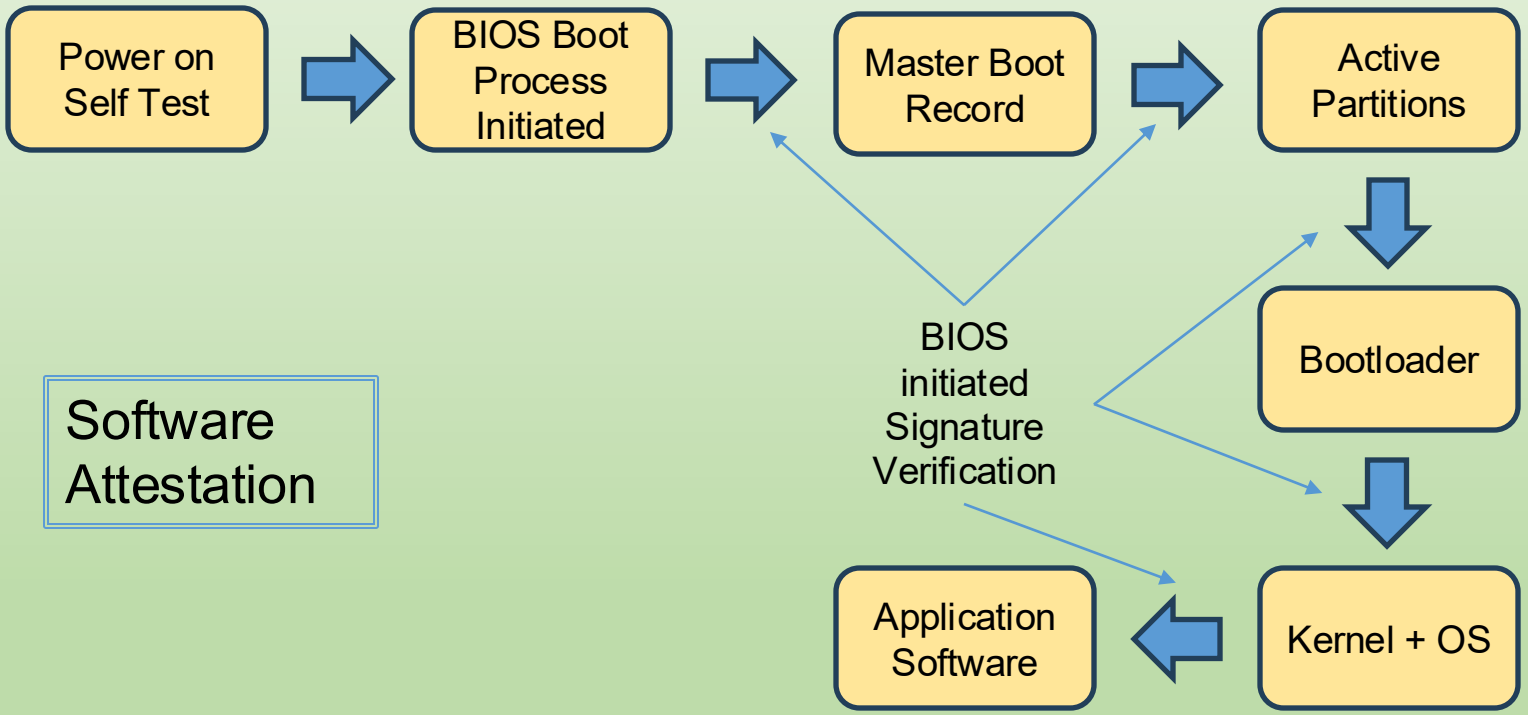

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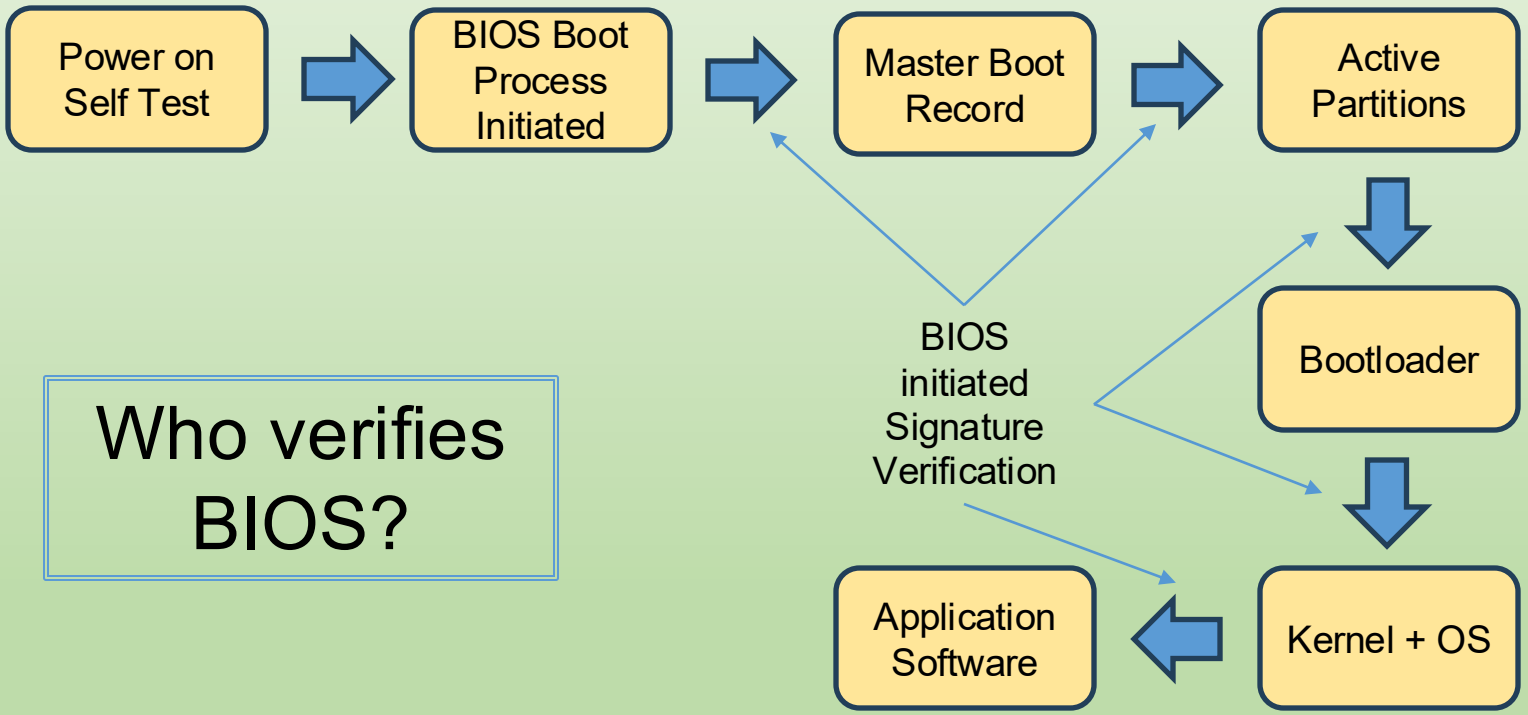
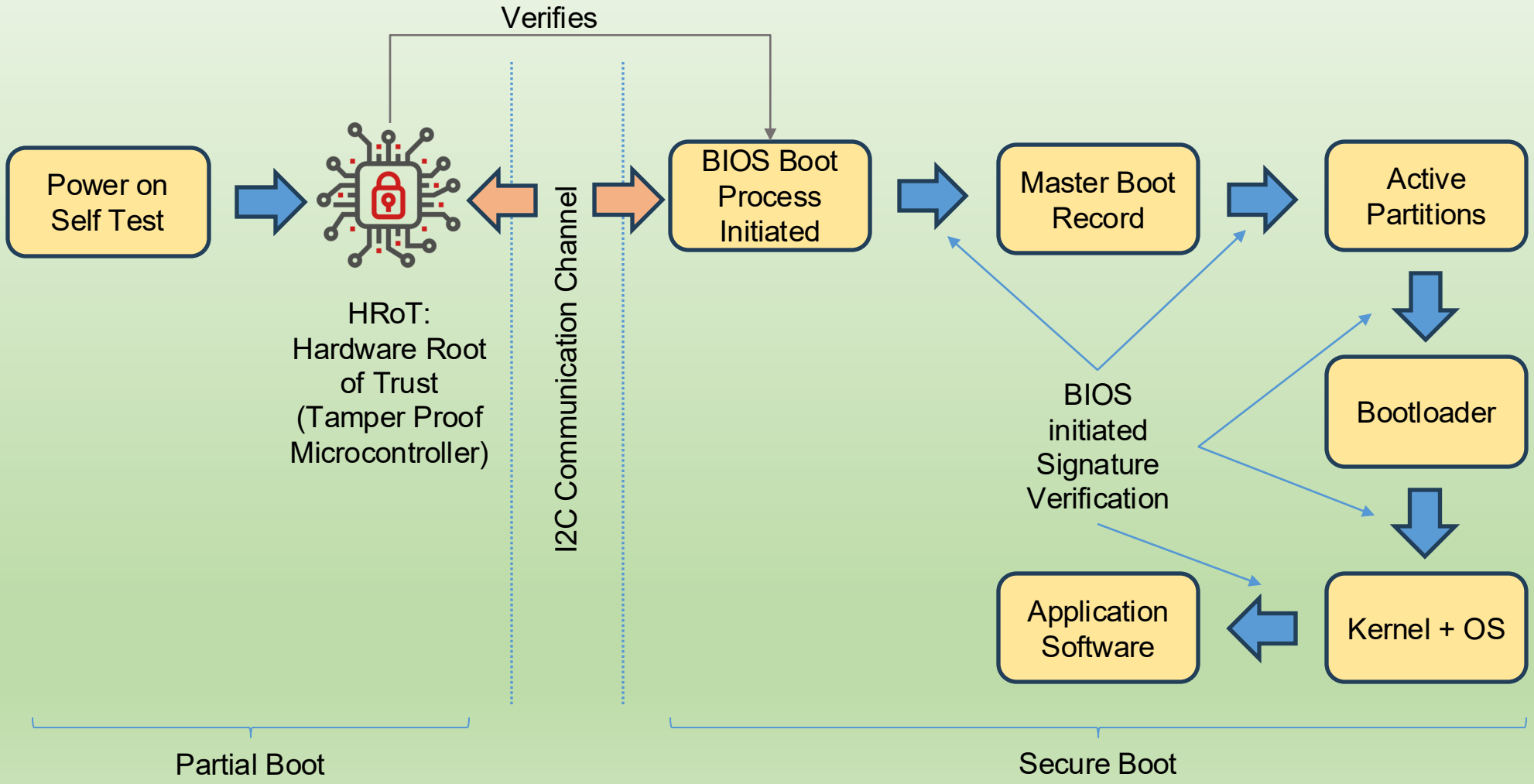
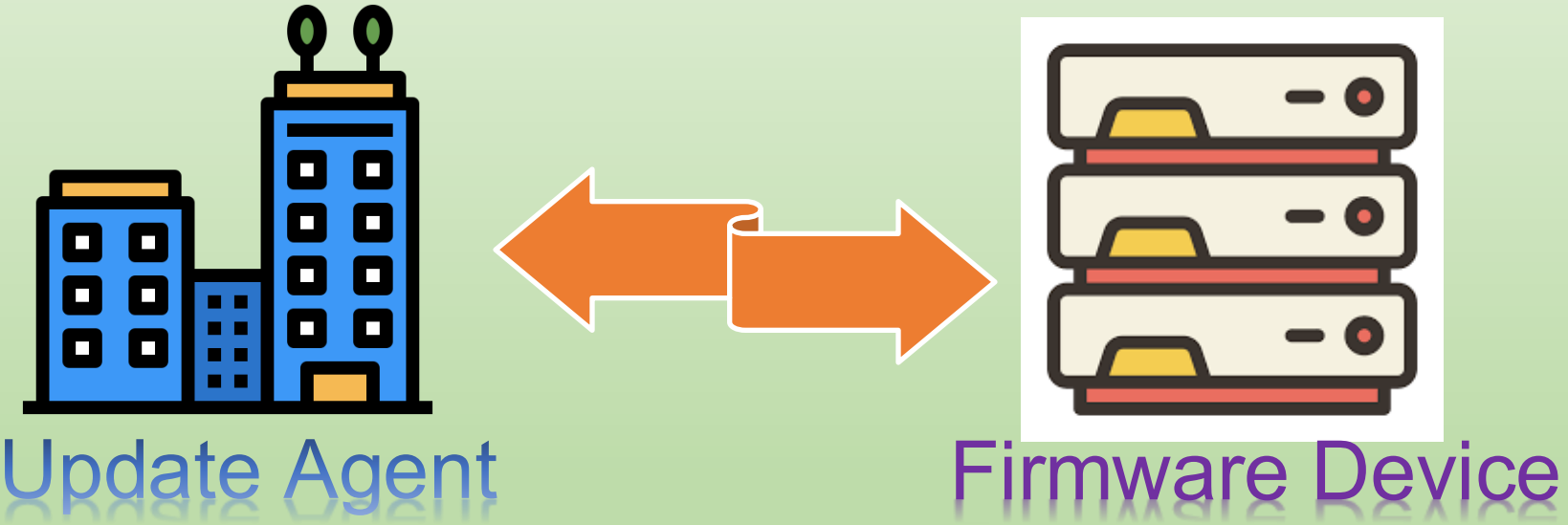


Background – Trusted Boot in PIT-Cerberus Protocol*



* Rakesh Podder et al, "The PIT-Cerberus Framework: Preventing Device Tampering During Transit," IEEE QRS 2024

Motivation – BIOS / Firmware Update



Motivation - BIOS / Firmware Update

Rollback Protection Scheme

Dual-bank Update Scheme

Delta Update Scheme

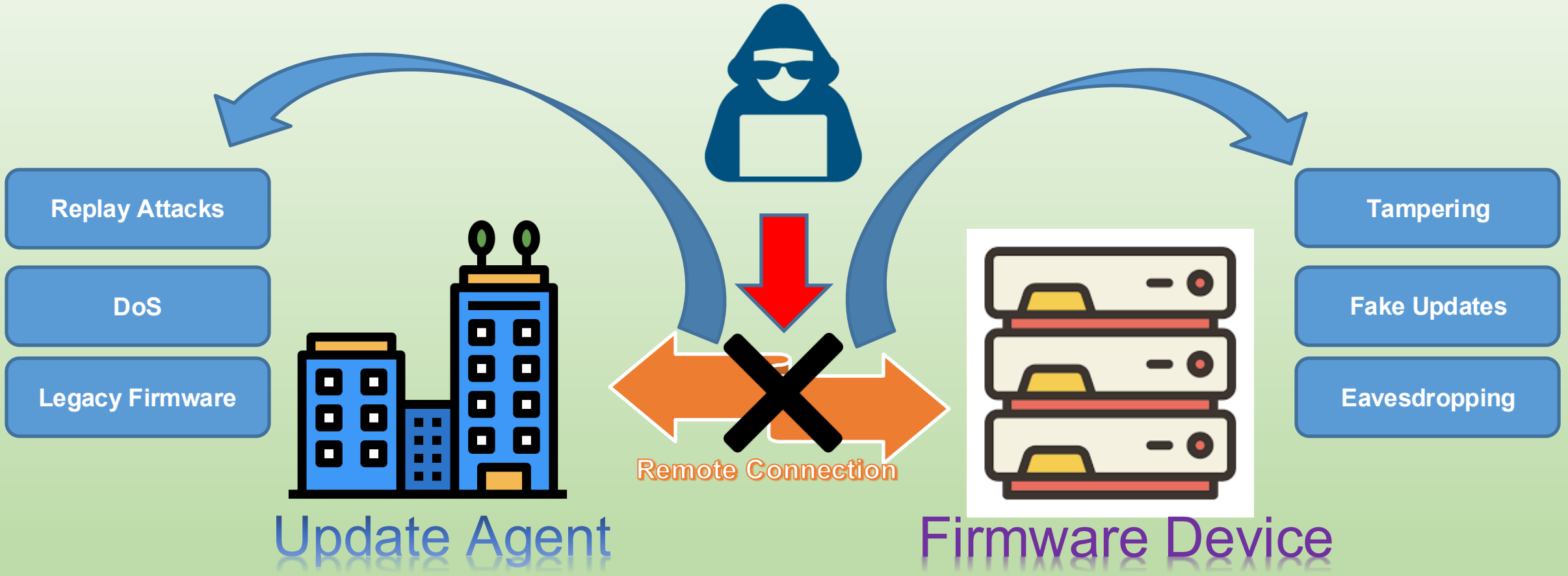
Over-The-Air (OTA)

Update Agent

Remote Connection

Firmware Device

Motivation - BIOS / Firmware Update



Ensuring secure remote firmware updates is pivotal to safeguarding devices from malicious intrusions, maintaining device functionality, and protecting sensitive data.

Problem Statement

- Insecure firmware updates risk vulnerabilities and device malfunctions.
- Traditional OTA update mechanisms can be insecure.
- Diverse update protocols can create compatibility issues.

Design secure firmware update protocol that is device independent and is standardizable

Benefits and Relevance

- Protecting device ecosystems from evolving cybersecurity threats and ensuring uninterrupted device performance
- As industries increasingly rely on interconnected devices, ensuring secure firmware updates becomes paramount to maintaining operational integrity, protecting intellectual property, and complying with regulatory standards
- Modern devices are an amalgamation of components from various suppliers. Using standardized and secure update mechanisms ensures consistency and security across the board

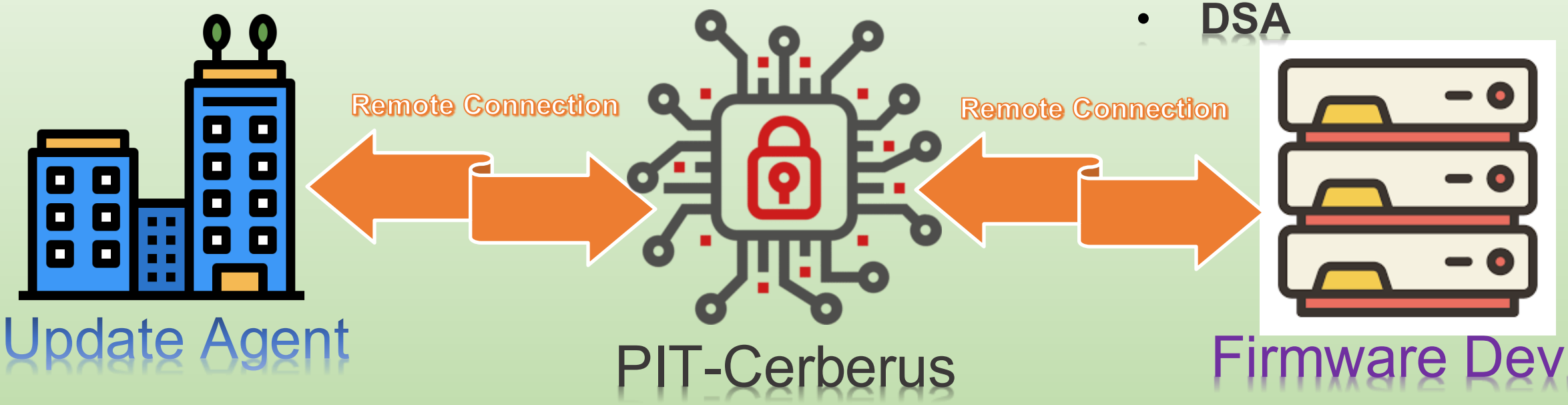
Solution – S-RFUP

Standardization

- PLDM
- MCTP

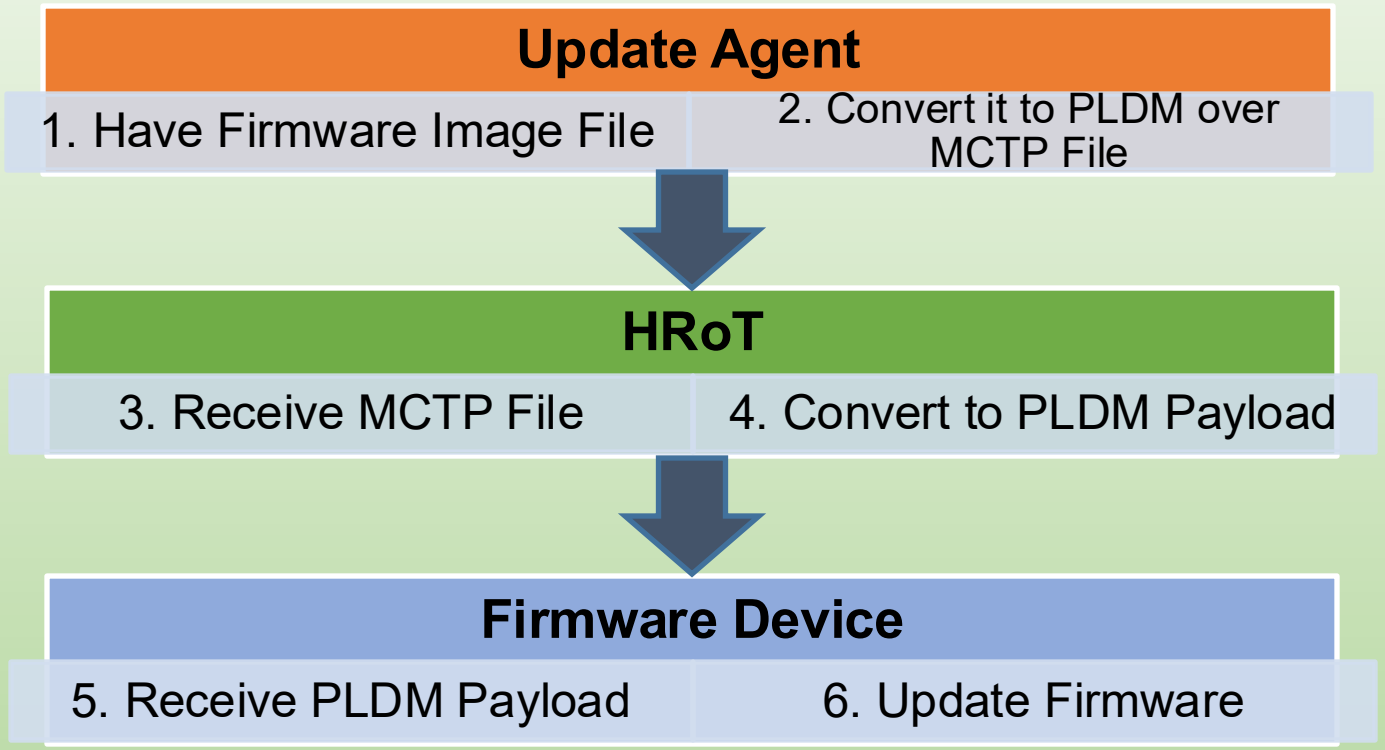
Security

- AES-256
- ECDH
- DSA



Establish an end-to-end secure pipeline for remote firmware updates

Hi-Level Specification



Platform Level Data Model (PLDM) for Firmware Update Specification

Platform Level Data Model (PLDM) over MCTP for Remote Update

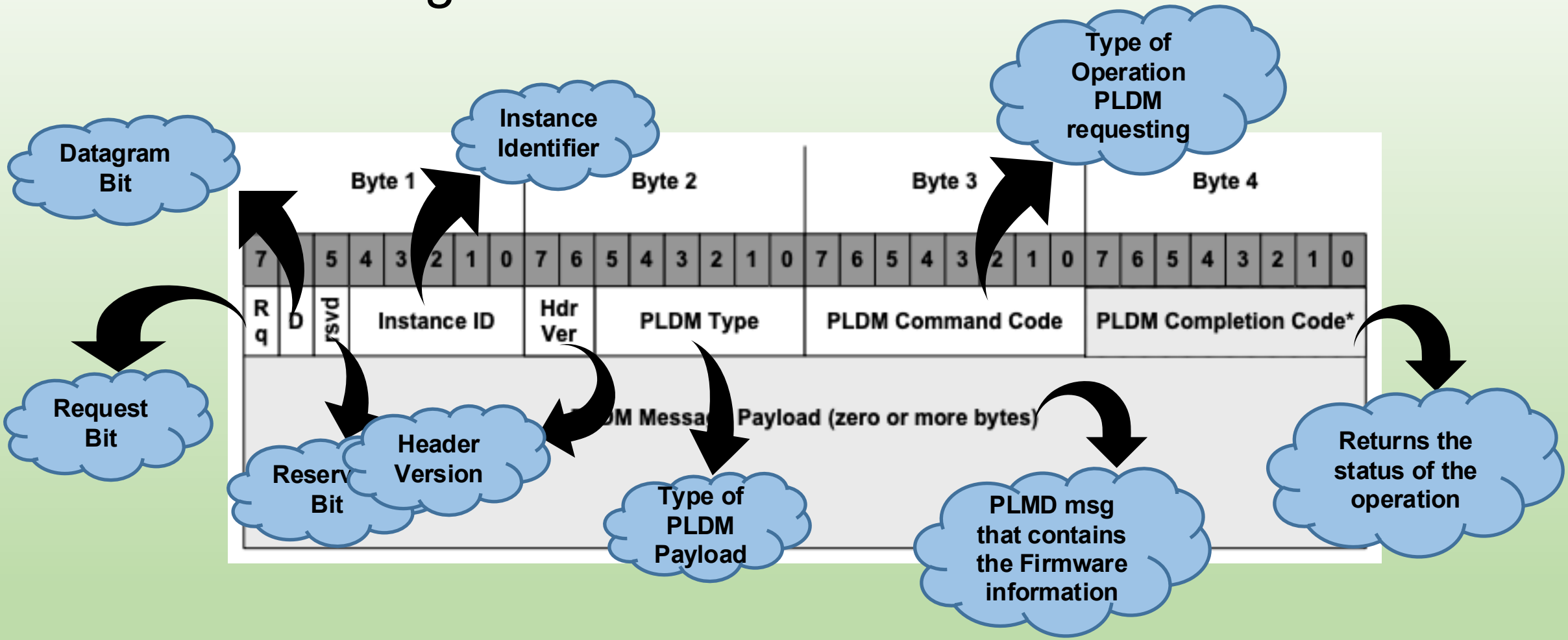
Project Cerberus

- Hardware root of trust for server platforms
- Provides functionality to enforce secure boot for firmware
- Provides mechanism to securely attest to the state of the device firmware

Platform Level Data Model (PLDM)

- Standardized framework for system management
- Enables structured control of hardware components
- Used in data centers and servers
- Binary encoding for efficient data transmission
- Supports hardware queries, configuration, and diagnostics
- Extensible for custom management tasks
- Integrates with management tools

PLDM Message Format



Reference: Platform Level Data Model (PLDM) Base Specification DMTF

MCTP (Management Component Transport Protocol)

- Industry-standard transport protocol for platform management
- Designed for communication between management controllers and components
- Enables remote management and monitoring of platform hardware
- Supports various transport layers (e.g., SMBus, PCIe, etc.)
- Provides a framework for secure communication
- Enables efficient and standardized hardware management

Platform Level Data Model (PLDM) over MCTP Binding Specification

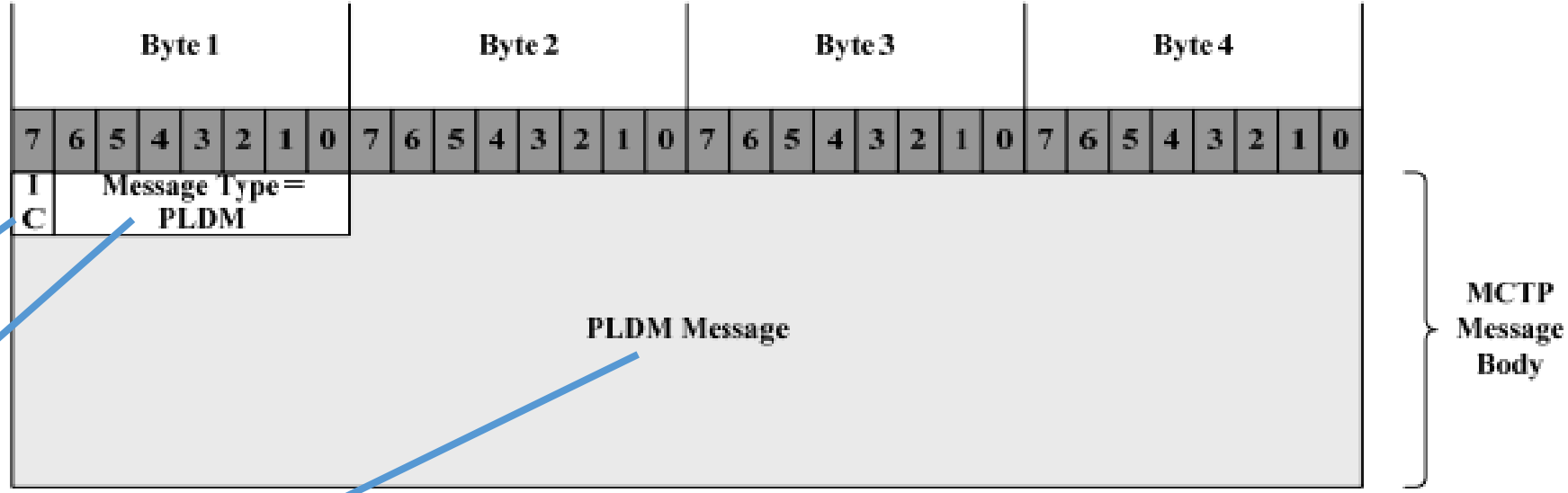


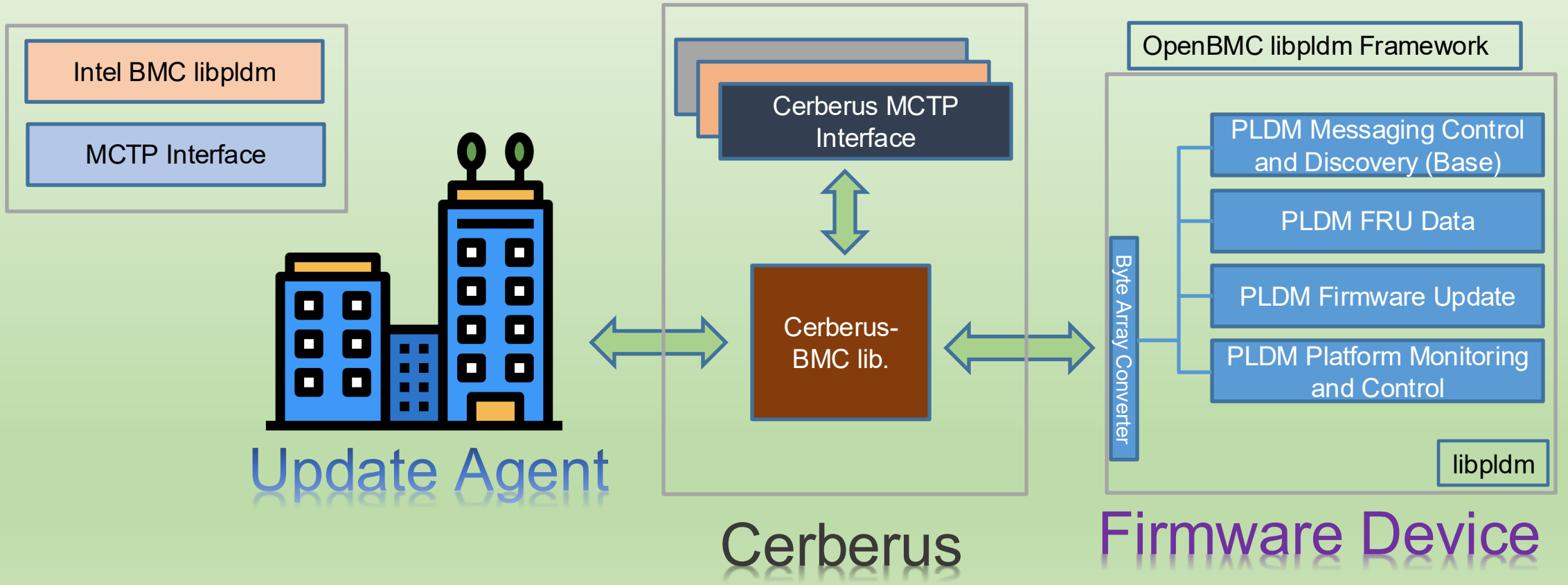
Figure 1 – PLDM over MCTP Message Fields

Table 1 – PLDM over MCTP Message Field Descriptions

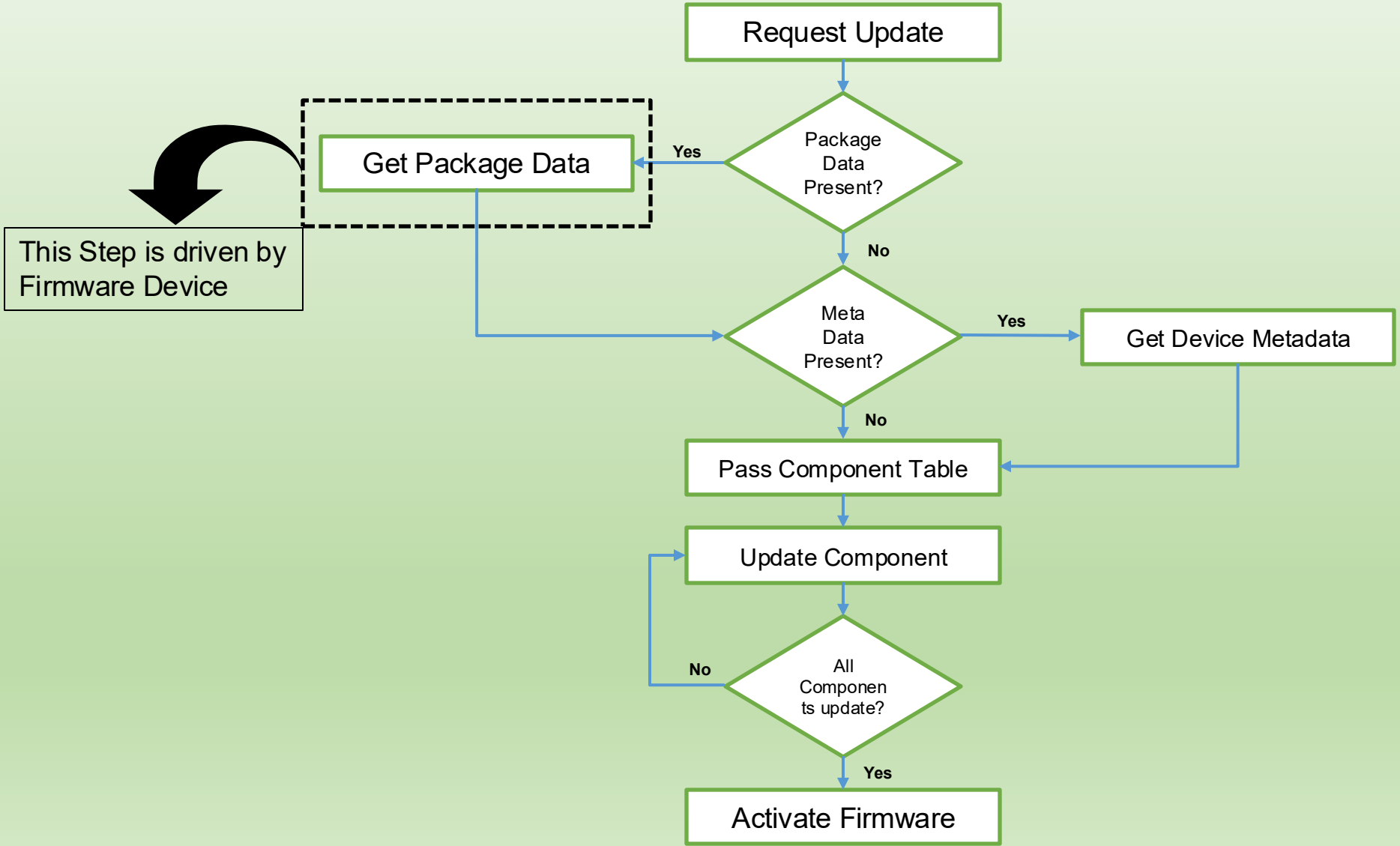
Field Name	Field Size	Description
IC	1 bit	Message Integrity Check bit = 0b PLDM over MCTP messages do not include an overall Message Integrity check field.
Message Type	7 bits	PLDM = 0x01 (000_0001b) This field identifies the MCTP message as carrying a PLDM message.
PLDM Message	Variable	The base PLDM message fields are defined in DSP0240.

Reference: Platform Level Data Model (PLDM) over MCTP Binding Specification DMTF

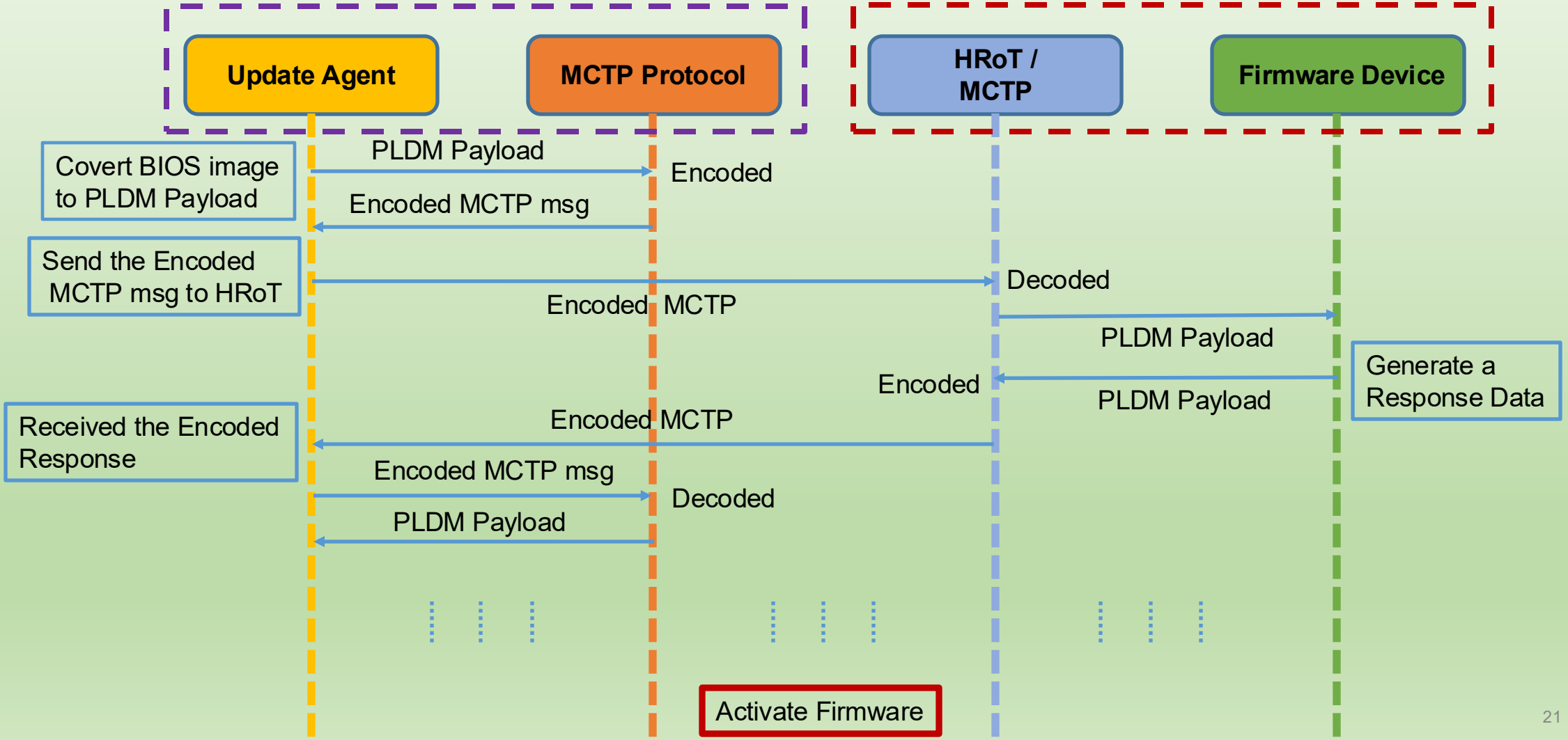
Libraries and Framework



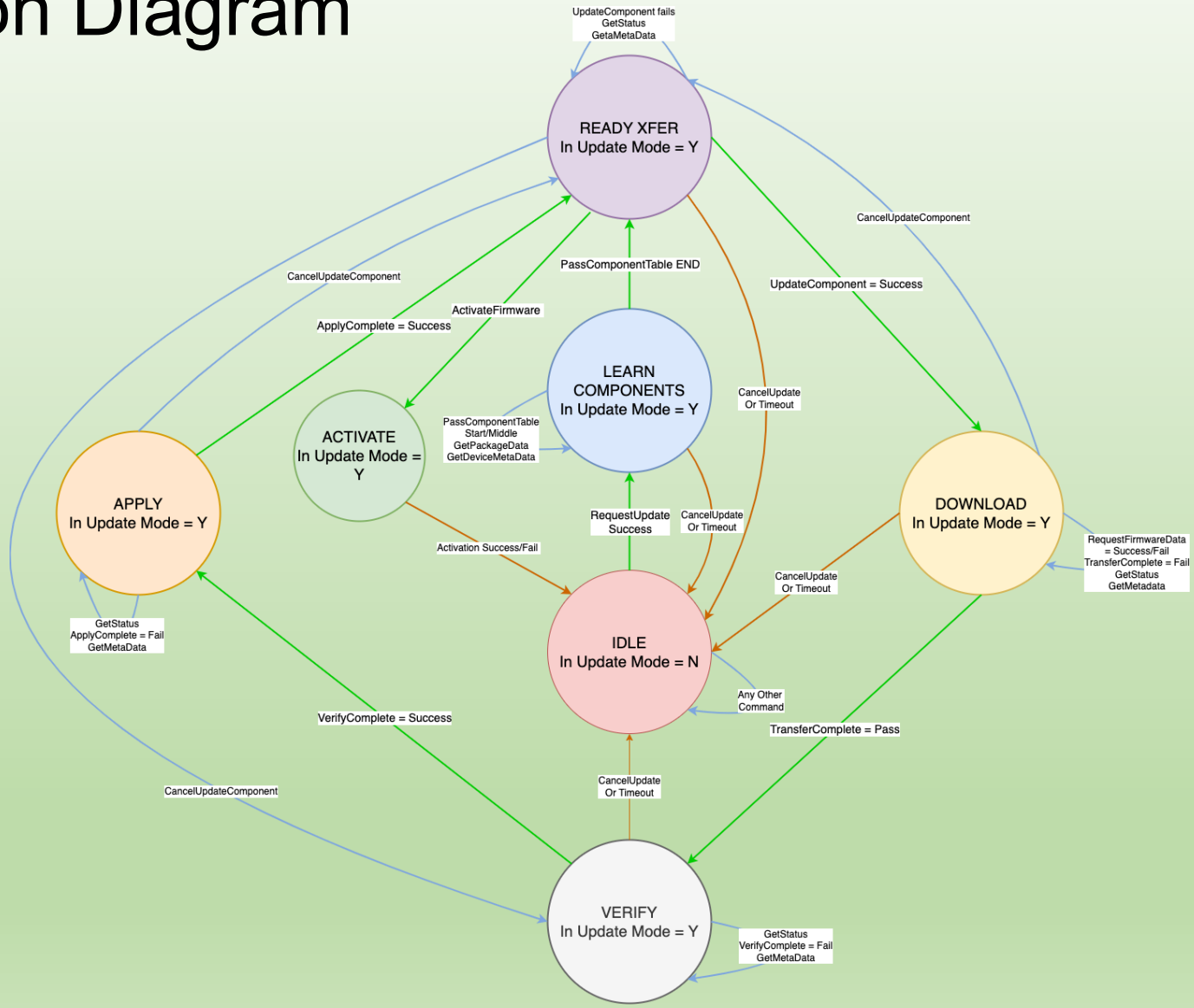
High Level Firmware Update Flow



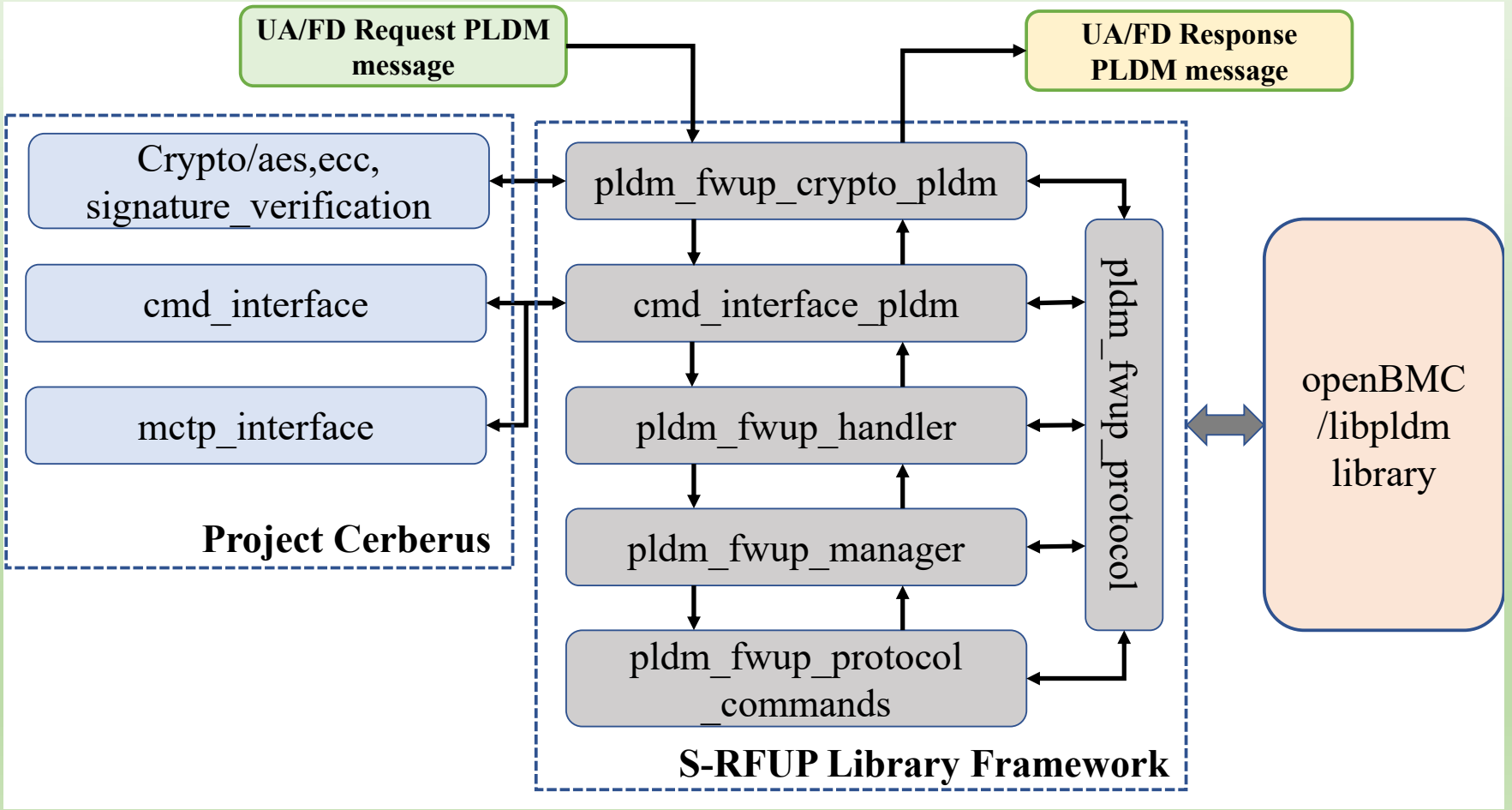
S-RFUP Protocol



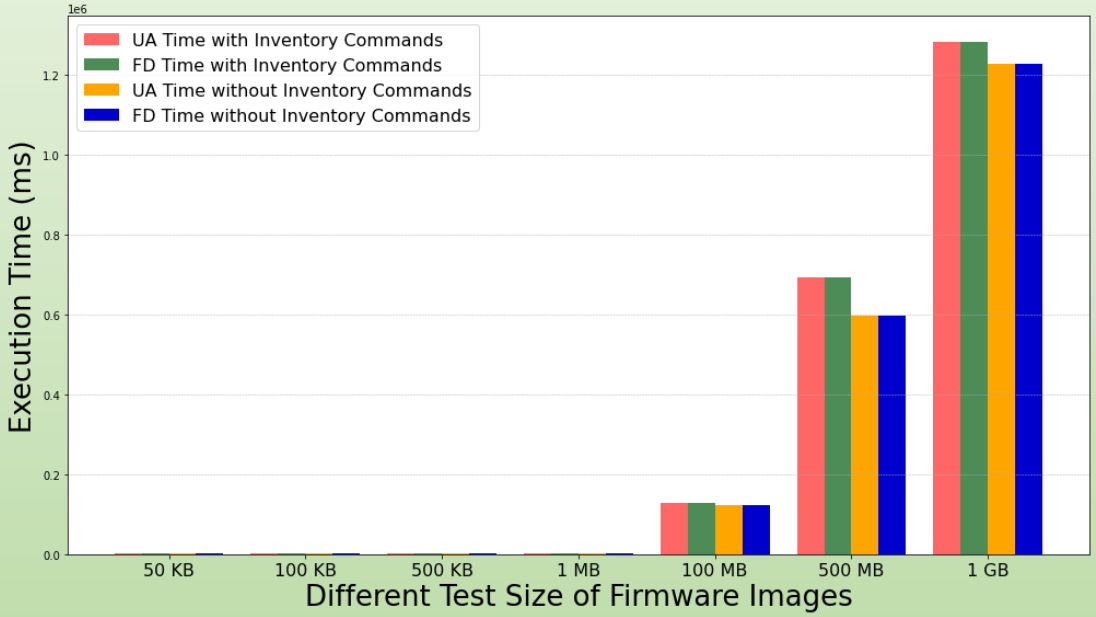
S-RFUP State Transition Diagram



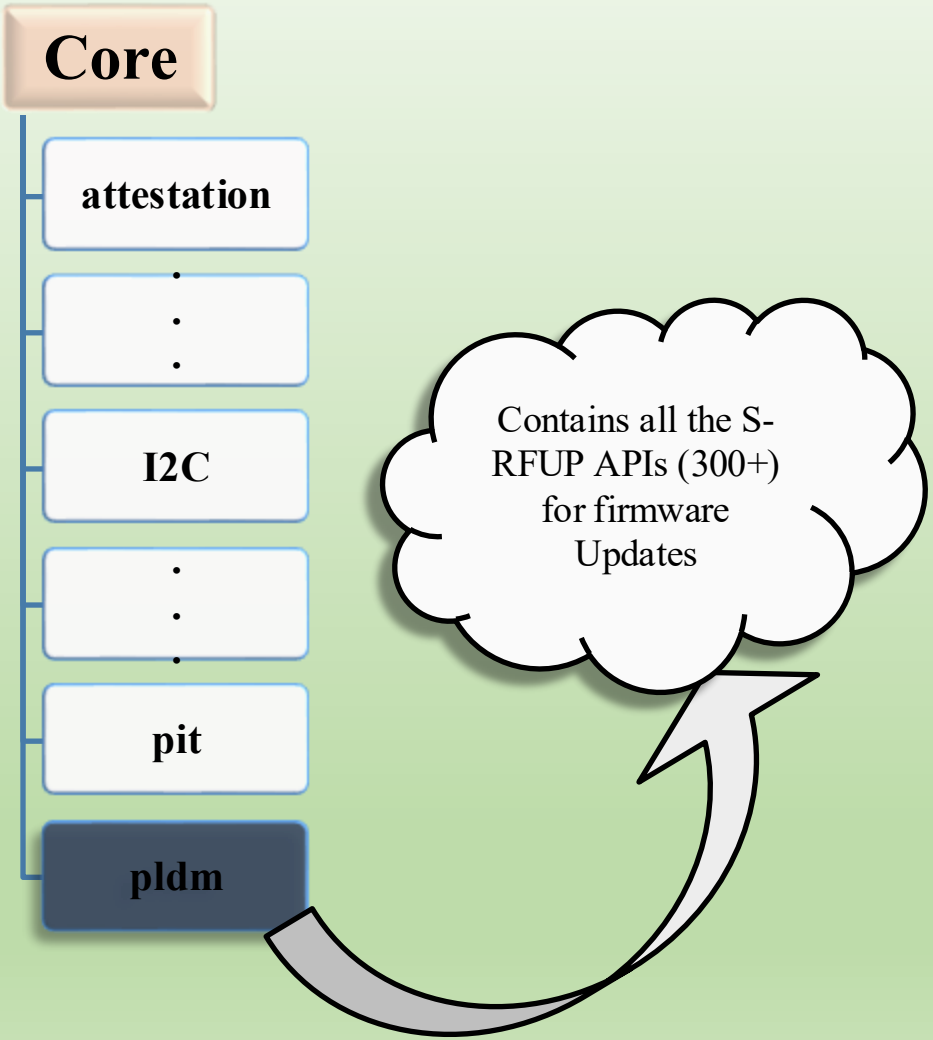
Libraries and Framework



Evaluation



UA Time vs FD Time for Firmware Update Tests (with and without Inventory Commands).



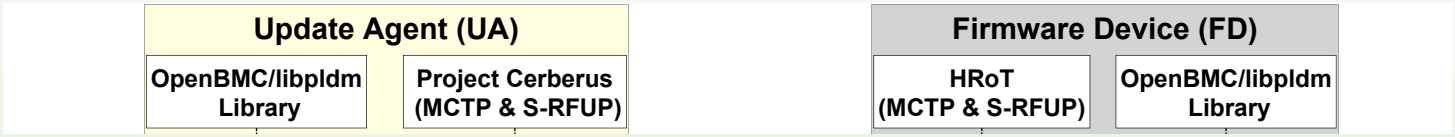
Conclusion & Future Work

- Have a complete and secure Firmware Update Protocol that adheres to industry standards.
- Incorporated protocol into Microsoft Cerberus Framework.
- Ongoing testing and optimizing the proposed protocol.
- Formal Verification of S-RFUP protocol

Thank You

Questions?

S-RFUP FIRMWARE UPDATE PROCESS



S-RFUP FIRMWARE UPDATE PROCESS

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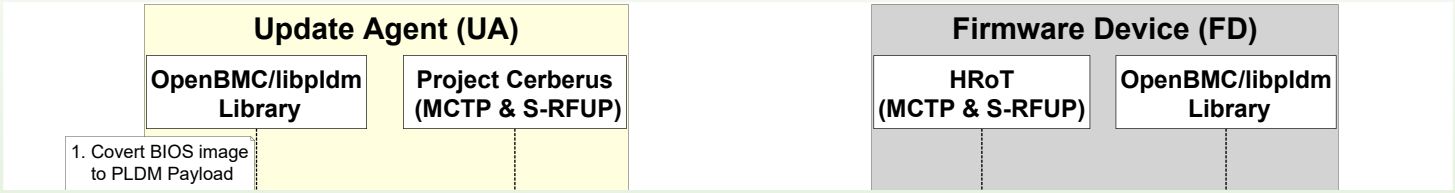

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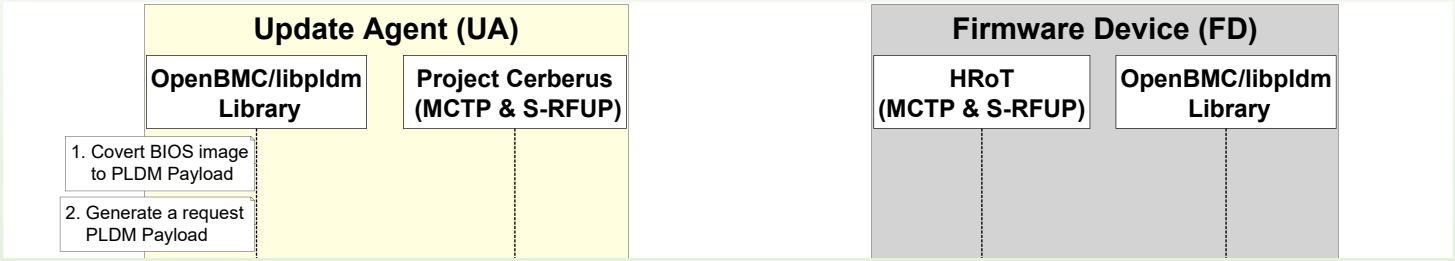

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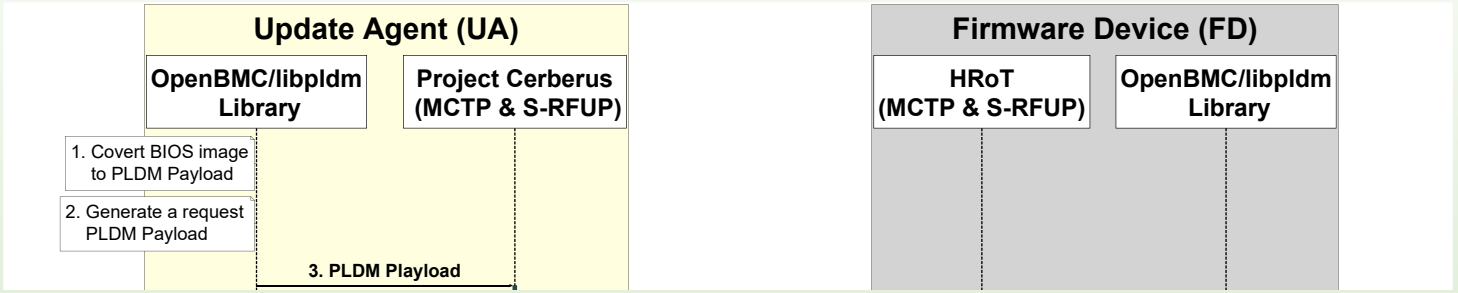

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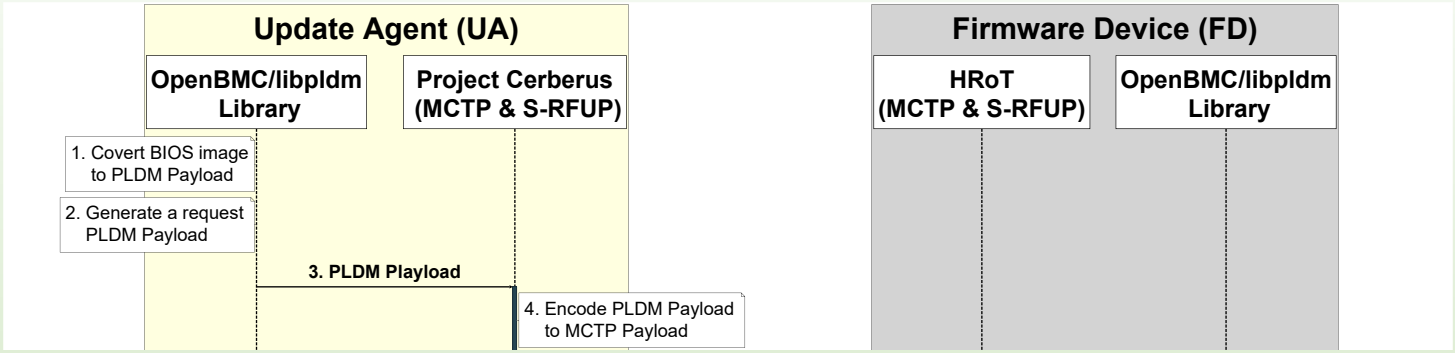

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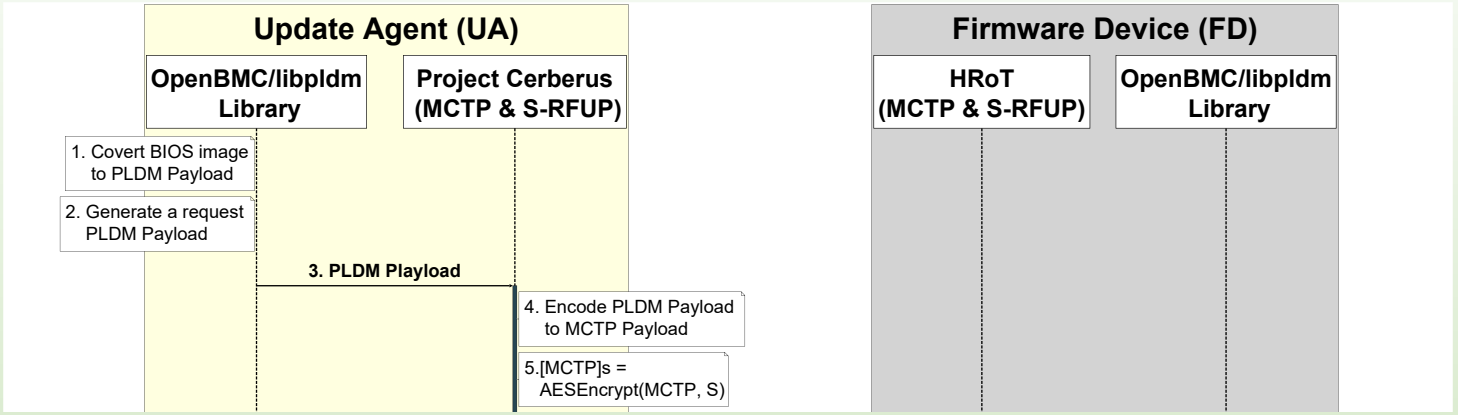

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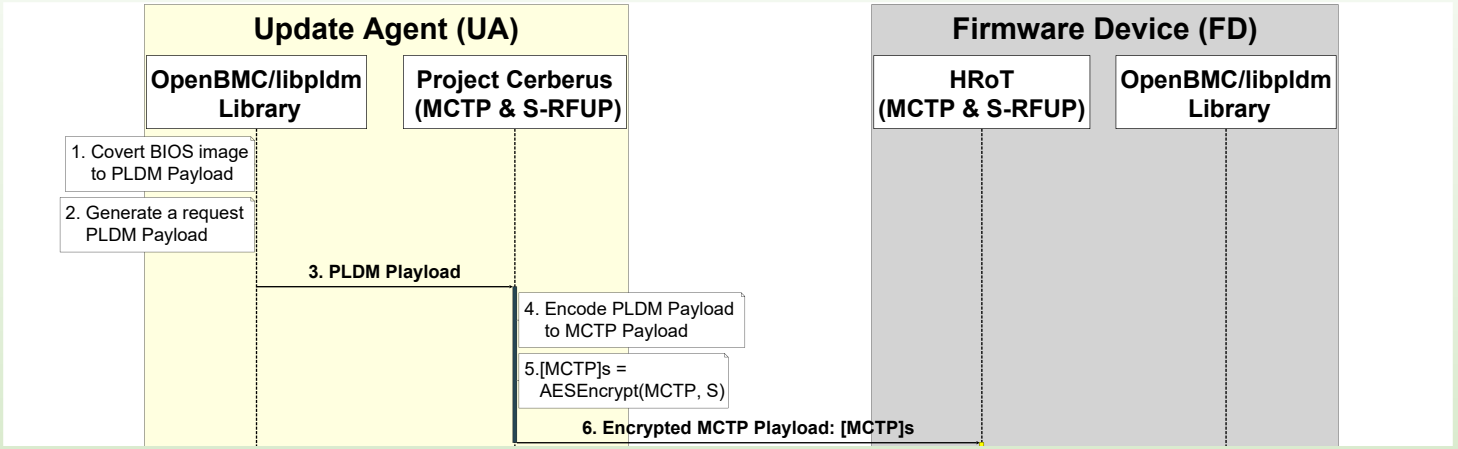

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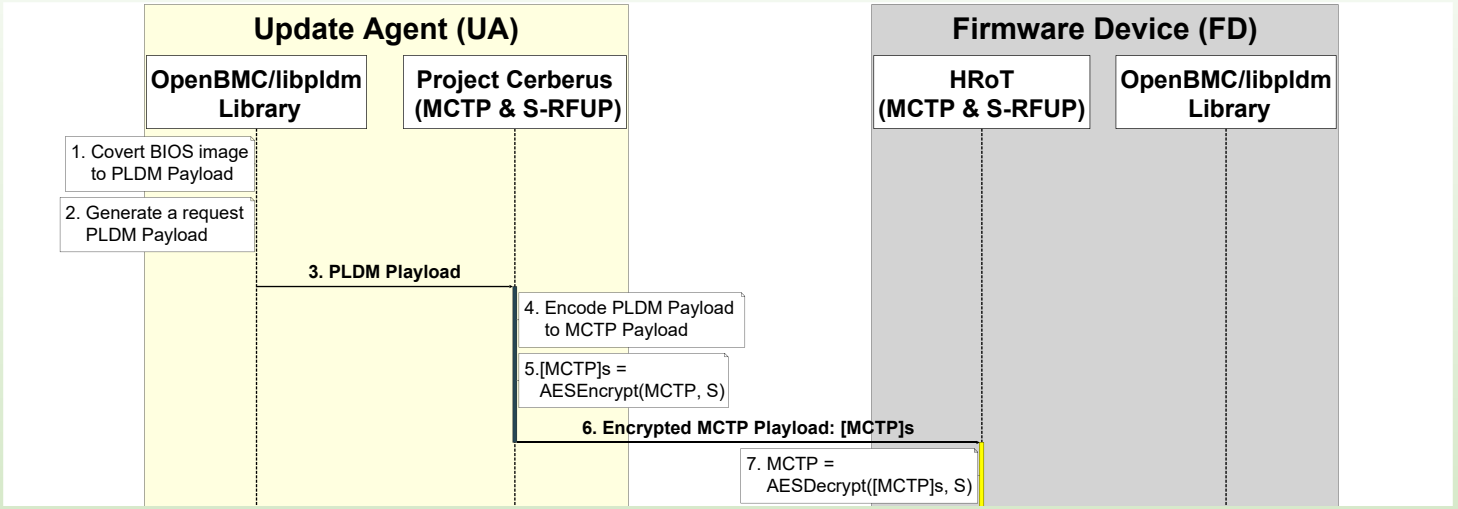

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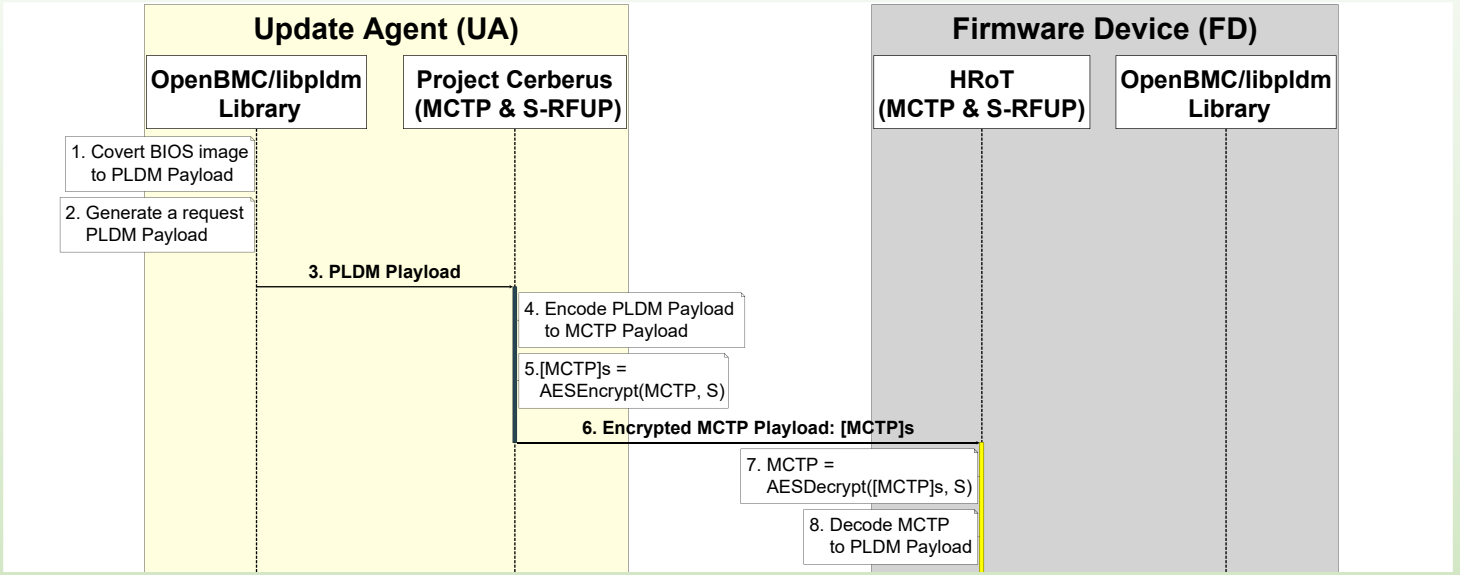

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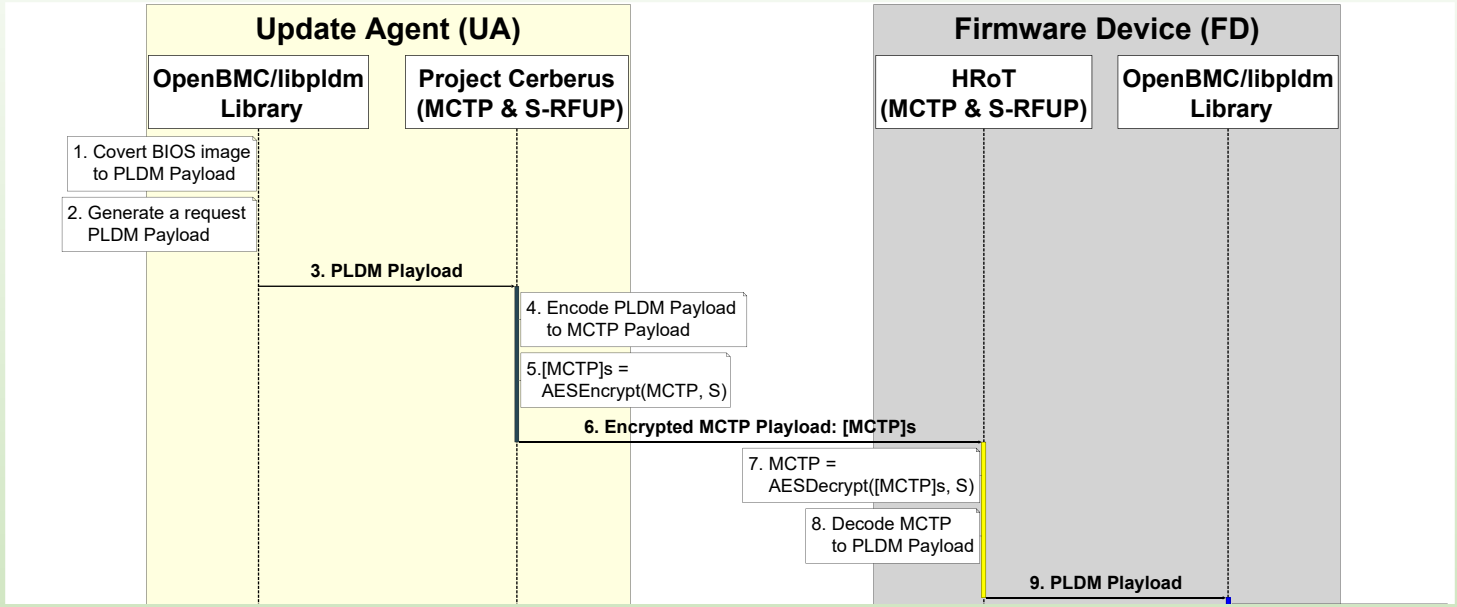

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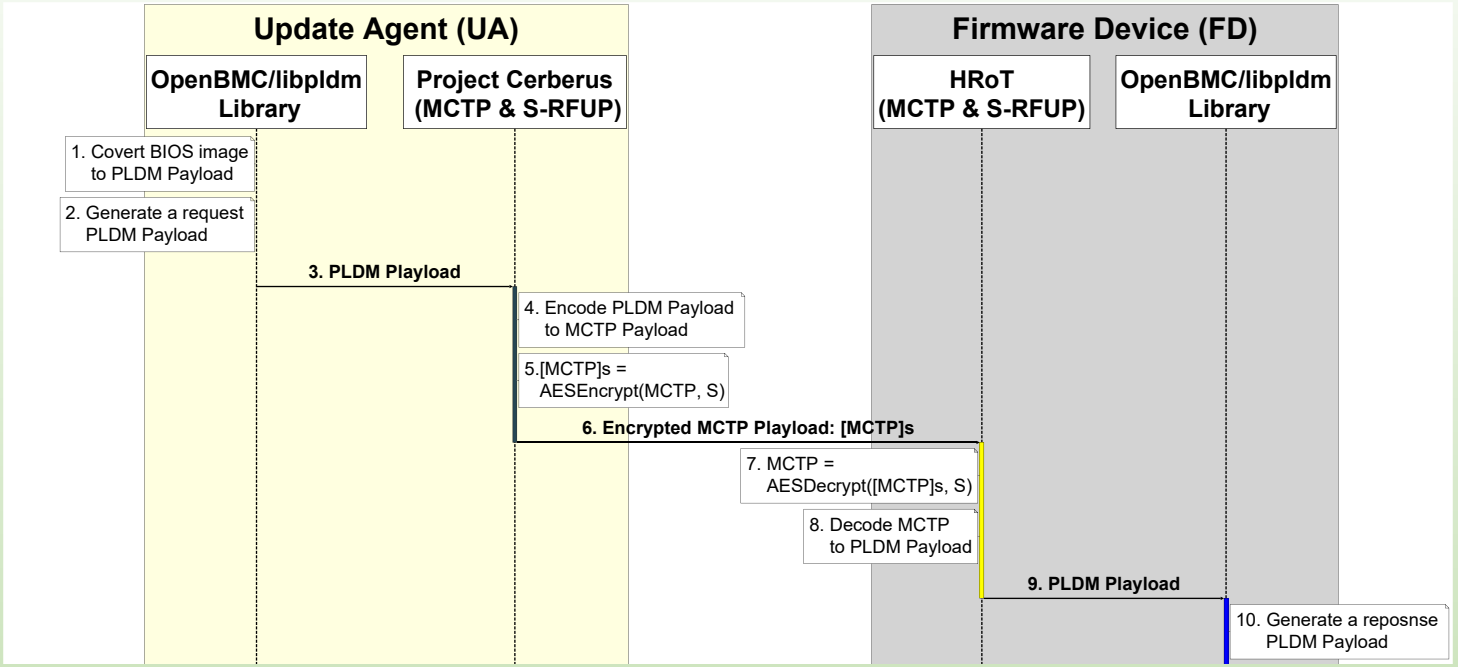

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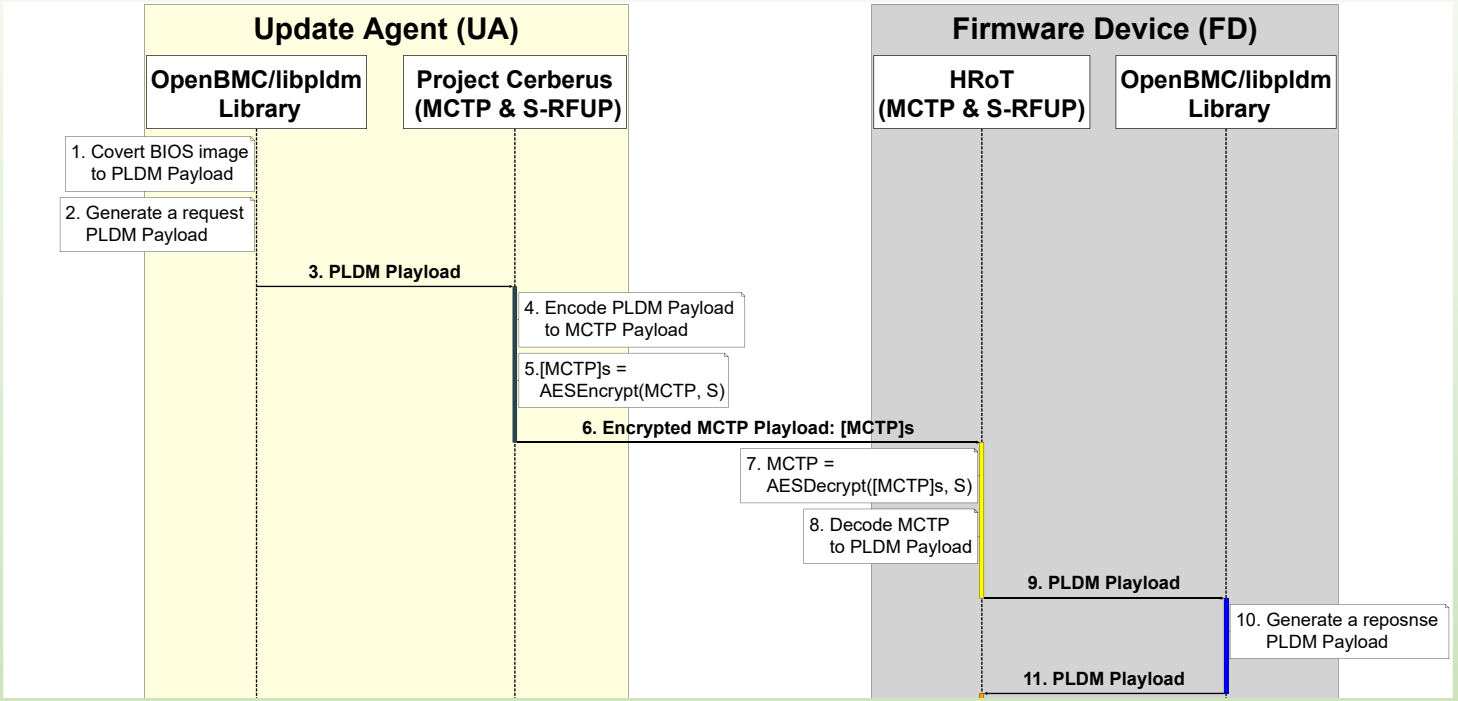

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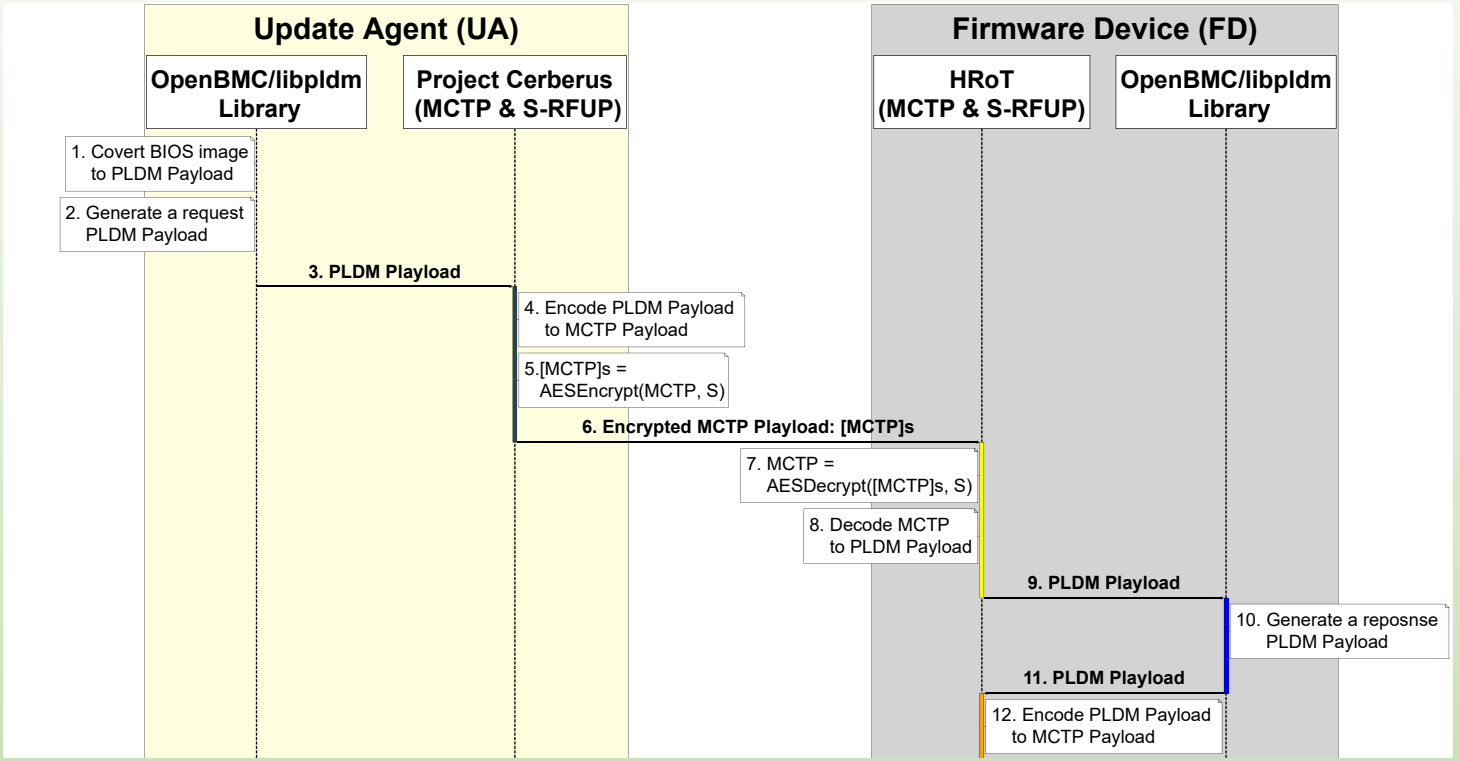

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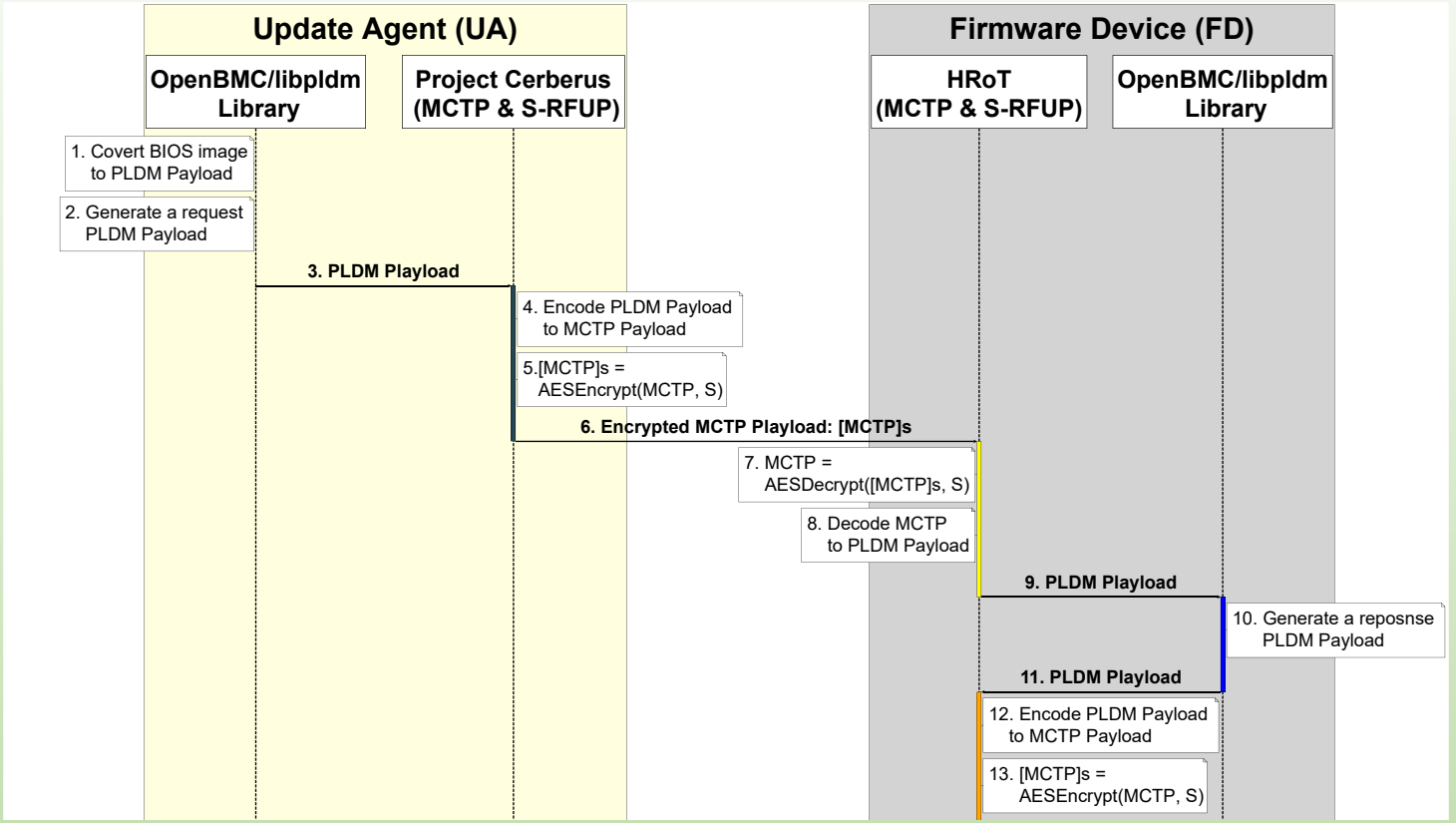

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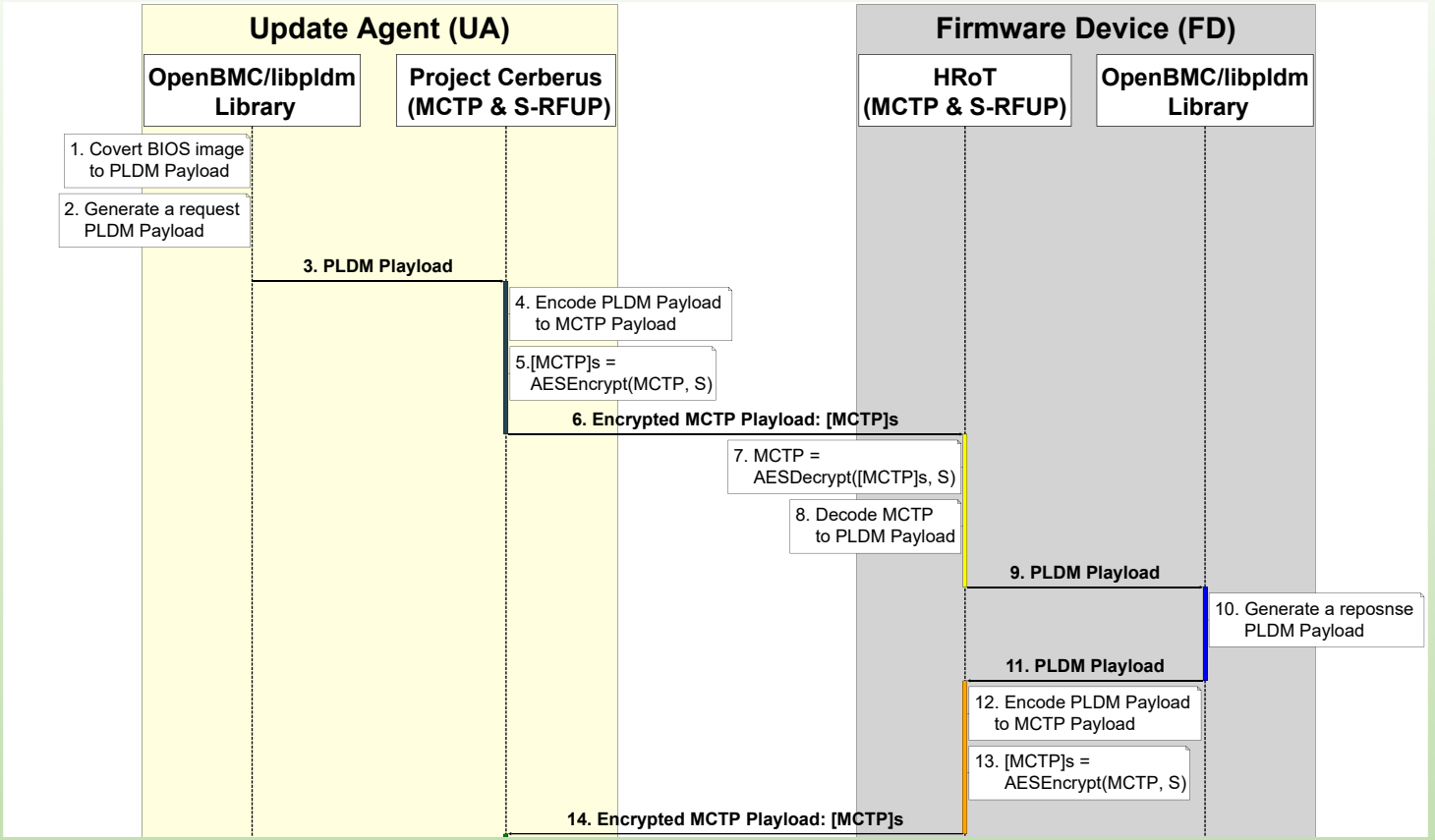

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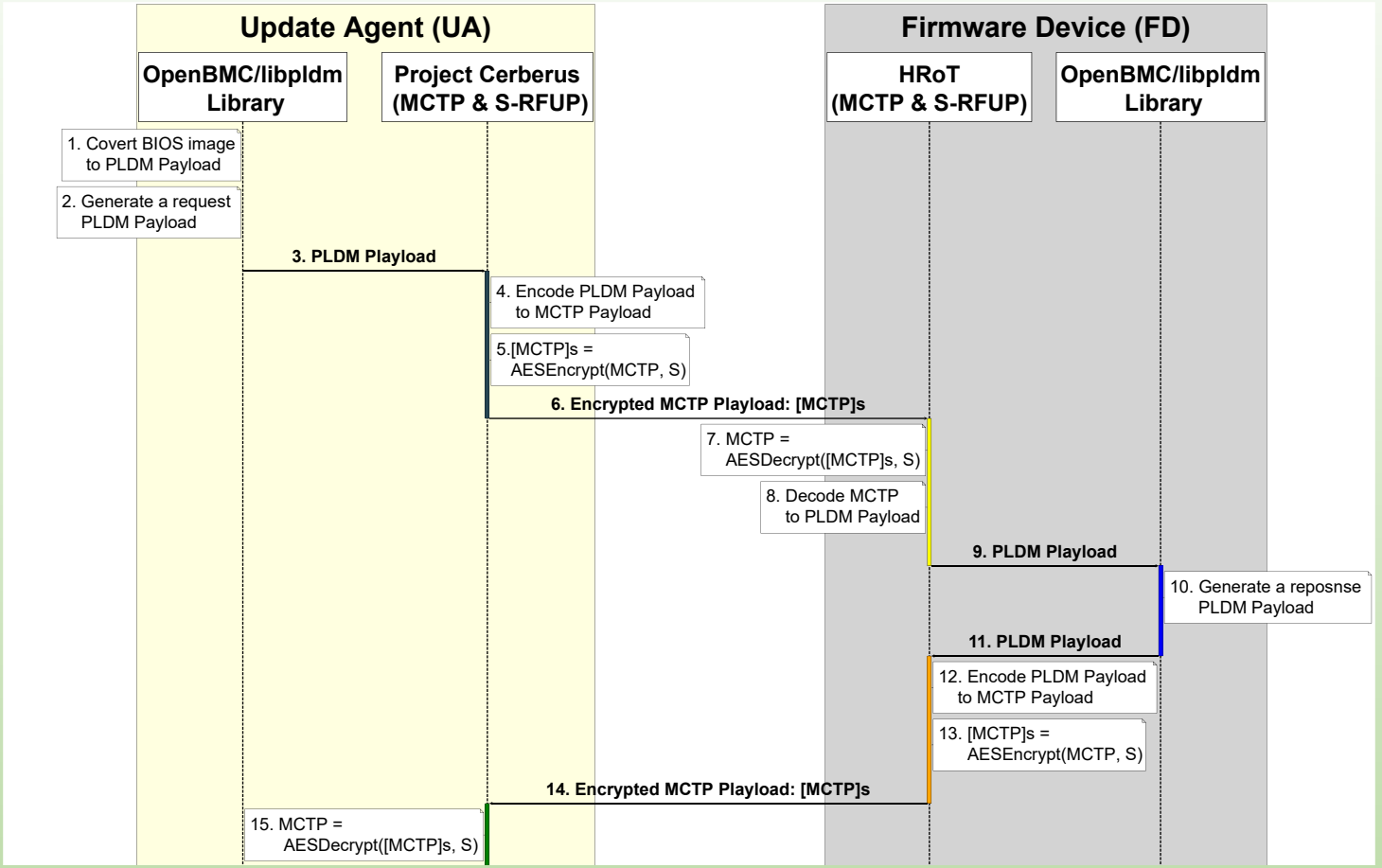

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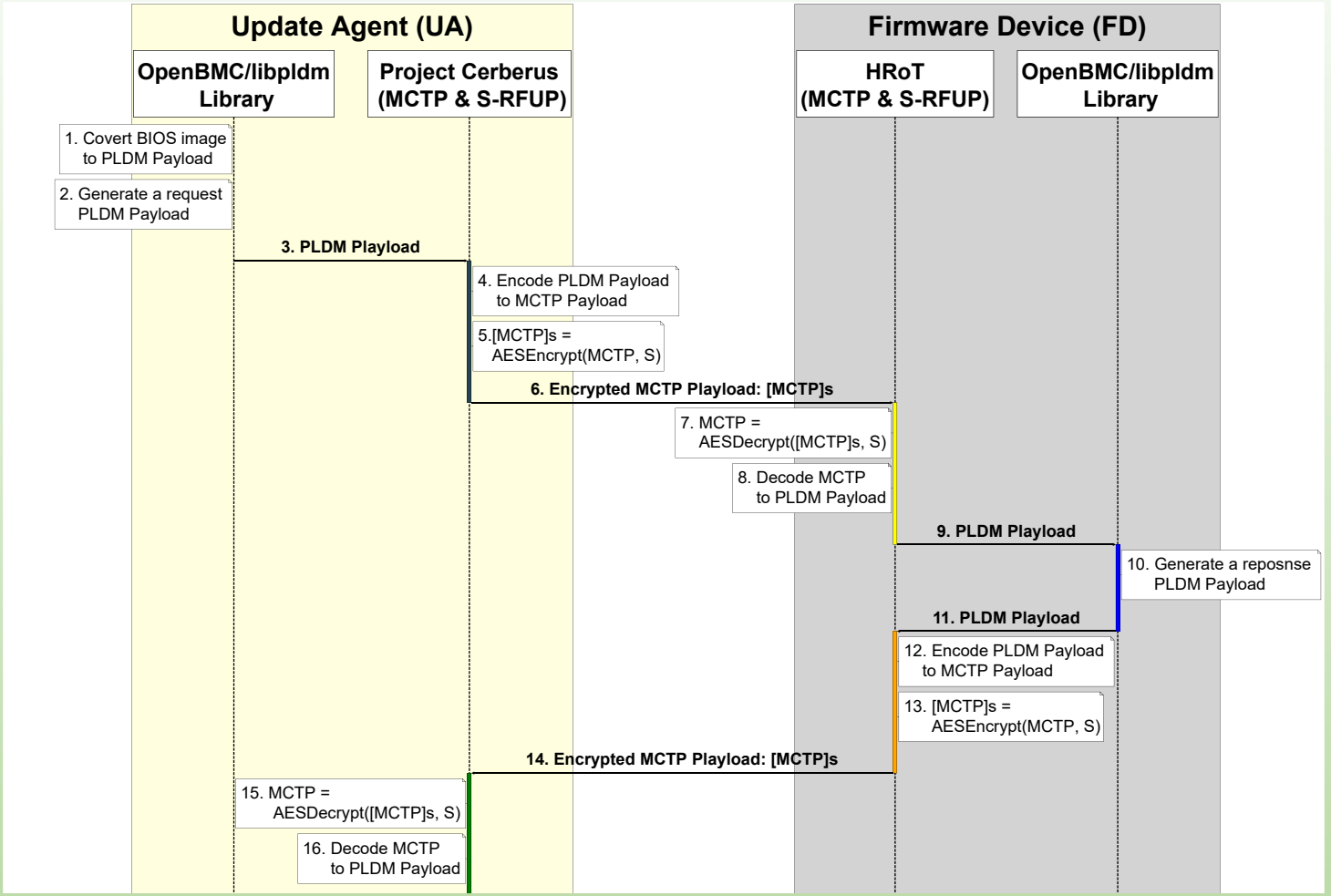

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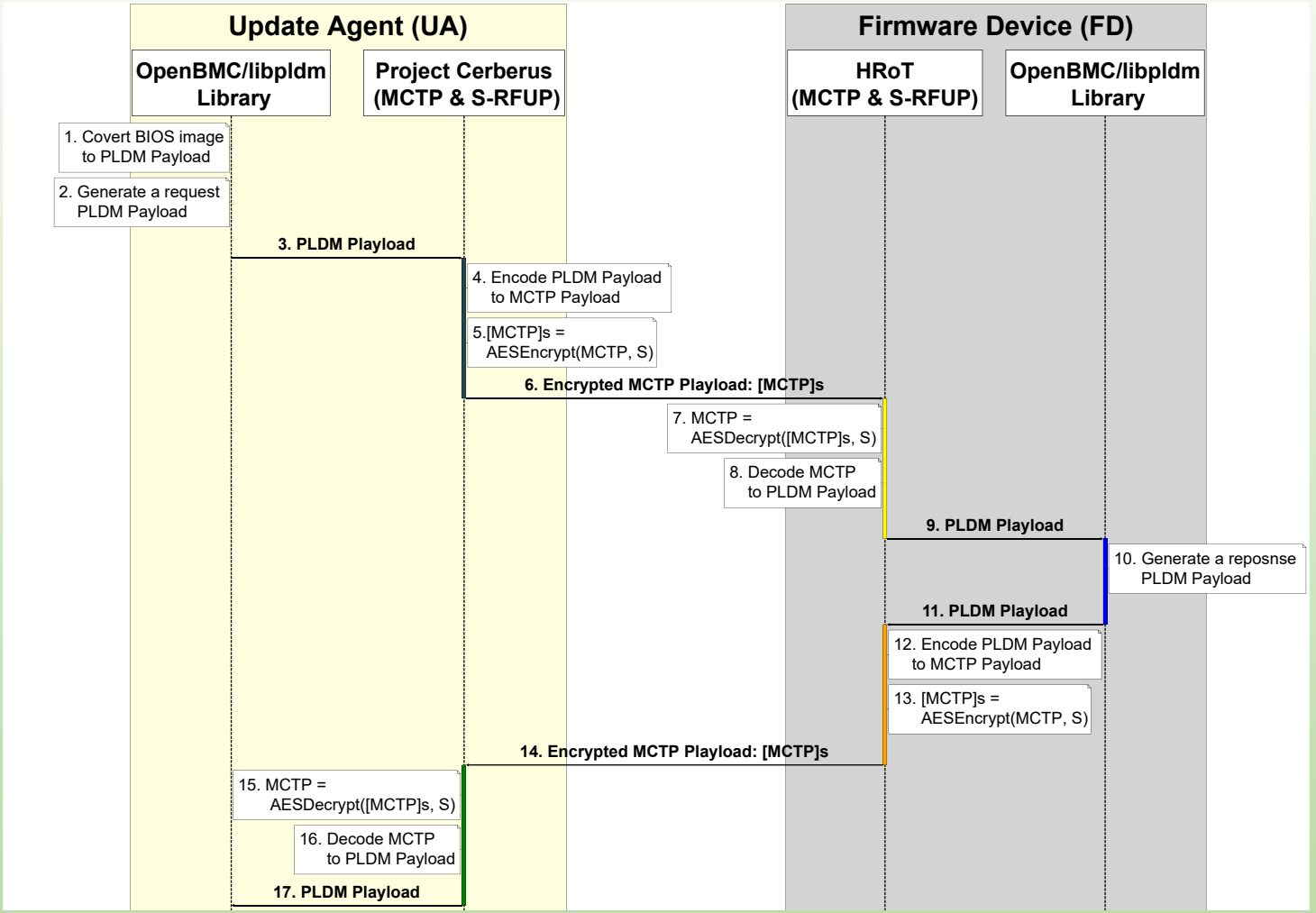

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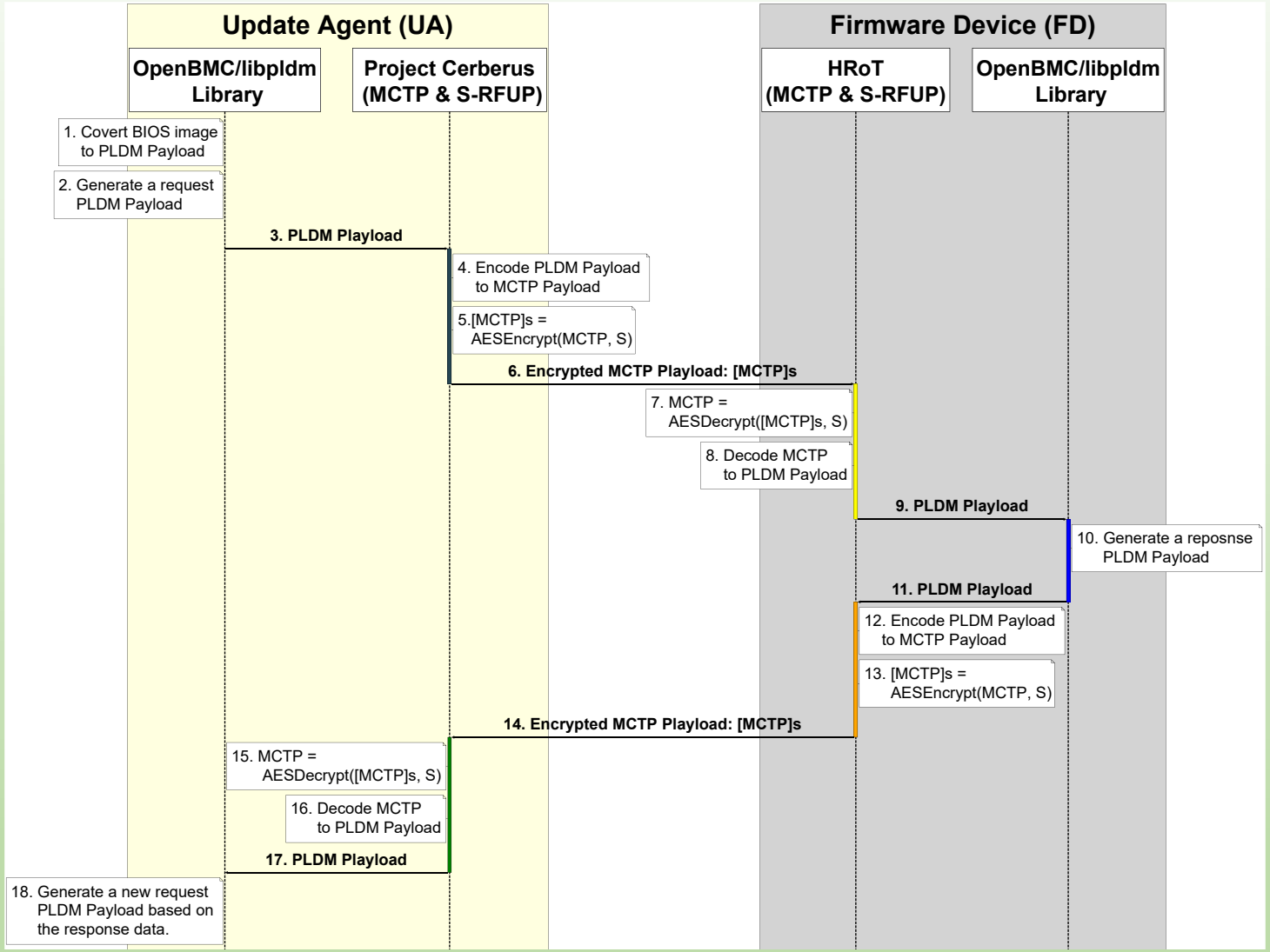

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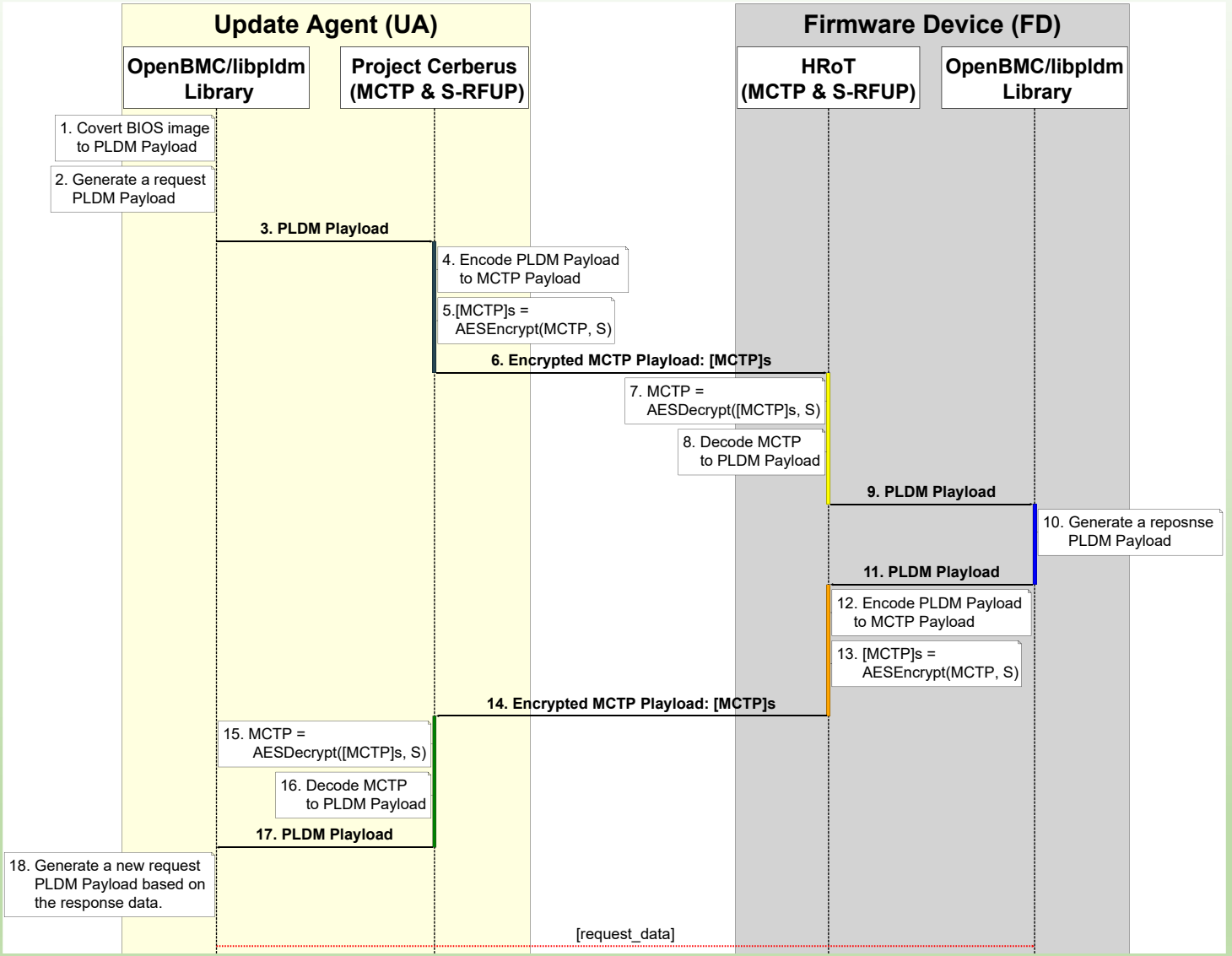

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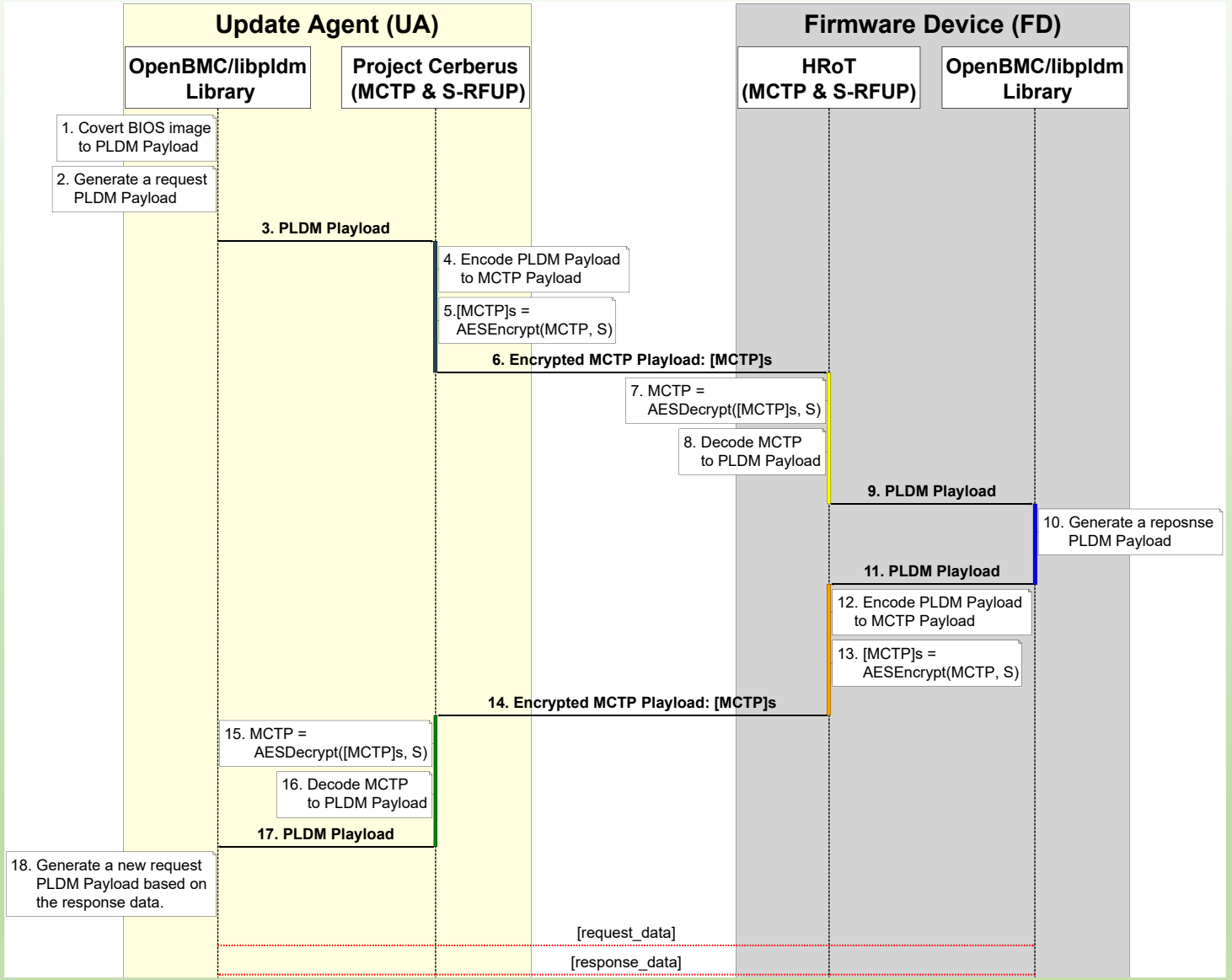

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