CMIS: THE KEY TO EFFICIENT MANAGEMENT OF PLUGGABLE MODULES IN NETWORKING

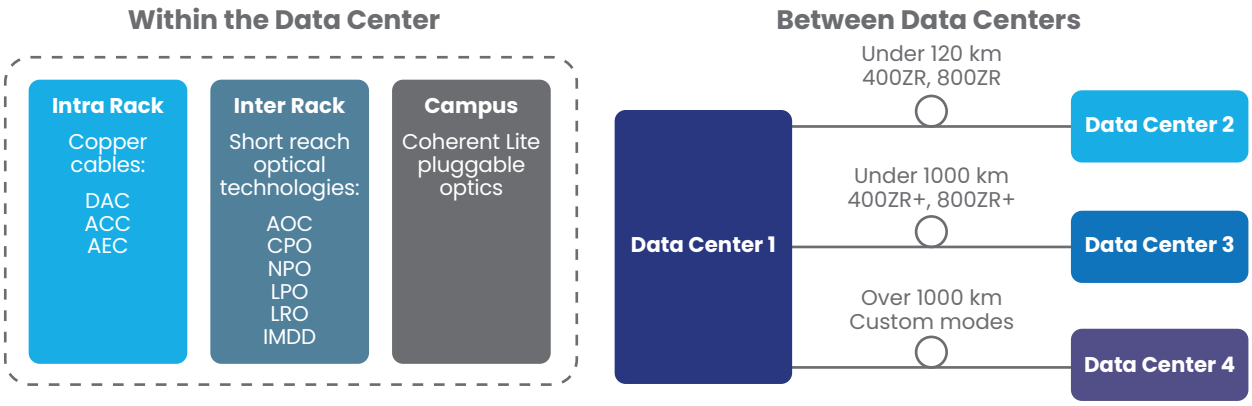
Exploring the Evolution, Implementation and Benefits of the Common Management Interface Specification

Introduction

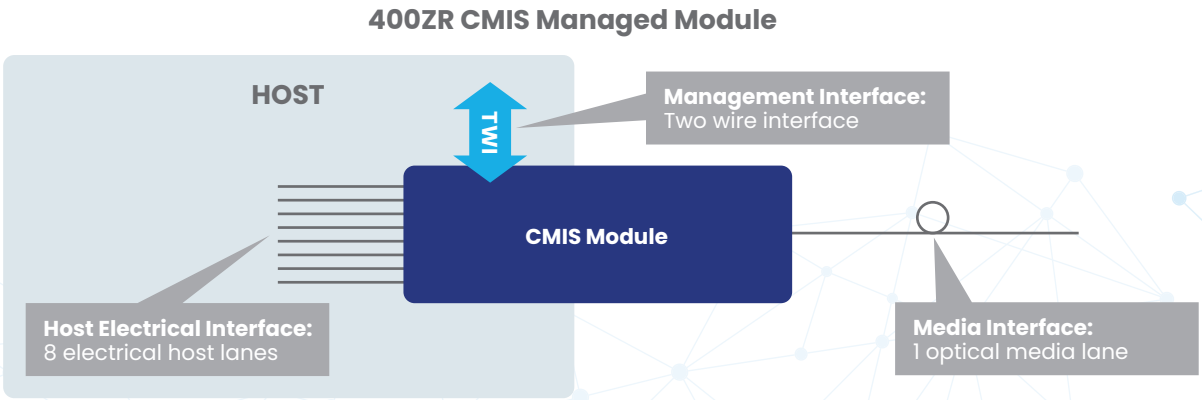
In today's networking world, standardized pluggable media modules—like copper cables and optical modules—are essential building blocks. These modules are widely used across industries, supporting various protocols, applications and performance levels such as bandwidth, power and reach. Their popularity stems from their ability to be easily replaced in the field, their interoperability across different systems and the competitive supply chain that drives innovation and cost-efficiency.

Over time, these pluggable solutions have evolved in physical design and technical capability, enabling them to support a broader range of performance features. This flexibility allows network operators to optimize their systems and create more efficient, high-performance platforms for computing, storage and networking. However, as these modules' complexity and their features have grown, the need for a standardized way to manage their interaction with host systems has become increasingly critical.

The rapid growth of large-scale data centers has further amplified this need. High-speed connectivity, reaching speeds of 400 GB/s to 1.6 TB/s, is now required at every level—within racks, across data centers and between data centers. Direct attach cables (DACs) and active optical cables (AOCs) address shorter-distance needs, while optical modules, both direct detect and coherent, extend the reach to tens and hundreds of kilometers, respectively. This ecosystem of pluggable solutions demands a robust, standardized management framework to ensure seamless integration and operation.



This white paper focuses on one crucial aspect of this ecosystem: the **management interface**. Specifically, it explores the **Common Management Interface Specification (CMIS)**, which provides a standardized method for managing the interaction between pluggable modules and the devices they are connected to, ensuring smooth operation and scalability in today's interconnected world.



From Fragmentation to Standardization: The Evolution and Structure of CMIS

Before the introduction of CMIS, the pluggable module industry faced significant challenges due to the lack of a unified management framework. Multiple management specifications existed, often driven by new technologies, and were designed to address specific applications such as Fibre Channels or Ethernet short reach. These application-targeted specifications, while helpful, were less generic and failed to provide room for growth or support for custom functionality. This fragmentation resulted in hosts being required to write custom code to integrate each vendor's pluggable module. Even with the same management specification and form factor, differences in initialization sequences and other variables between suppliers and media interfaces made integration cumbersome. This repetitive cycle of custom development for each generation of pluggable modules created inefficiencies for both host and module vendors.

To address these inefficiencies and enable new management capabilities, a group of industry experts formed an independent offshoot of the QSFP-DD MSA (Multi-Source Agreement) and developed CMIS. This specification was designed to generically manage the wide range of technologies within the pluggable module space. Using generic management concepts, CMIS could be reused across different module types and technologies. A key innovation of CMIS was the use of an advertising mechanism, allowing modules to describe themselves and their capabilities to hosts. This approach enabled the development of a generic host driver capable of supporting various module types and technologies. Flexible mechanisms were also incorporated, allowing modules to use as much or as little of the specification as needed for their specific applications.

Initially, CMIS was a single document, called "core CMIS," developed by the independent QSFP-DD offshoot. Core CMIS established the foundational functionality required to manage most pluggable modules. Recognizing the need for broader industry involvement and ongoing development, responsibility for CMIS was transferred to OIF. OIF, with its global ecosystem of component manufacturers, module suppliers, host platform developers and network operators, has played a critical role in ensuring the specification's continued relevance and evolution.

Under OIF's Physical and Link Layer (PLL) Working Group, CMIS has grown into a family of documents that address the growing diversity of applications and technologies. These additions, referred to as supplements, are typically application-specific while remaining compatible with the core CMIS framework. For example, C-CMIS (Coherent CMIS) was the first supplement added to address the needs of coherent optical modules. New supplements continue to be developed, ensuring that CMIS remains current and capable of supporting emerging technologies and use cases.

The continuous updates and collaborative development of CMIS ensure that it addresses inefficiencies in module management and enables innovation and scalability. As a living specification under OIF, CMIS remains a critical tool for simplifying and standardizing the management of pluggable modules across the industry.

Core CMIS

CMIS

- Core CMIS
- This Implementation Agreement (IA) defines the Common Management Interface Specification (CMIS), which may be used by pluggable or on-board modules, such as QSFP Double Density (QSFP-DD), OSFP, COBO, or QSFP, as well as by existing or future module developments with host to module management communication based on a two-wire interface. This IA is targeted for systems manufacturers, system integrators, and suppliers of CMIS compliant modules.

CMIS Supplements

C-CMIS

- Coherent CMIS
- Implementation Agreement created by the Optical Internetworking Forum for the MIS of Coherent Modules.

CMIS-VCS

CMIS Versatile Control Set (CMIS-VCS) generalizes and extends the current CMIS base Control Sets [1] to 56 allow for support and control of advanced SI capabilities.

CMIS-LT

- CMIS - Link training
- CMIS extensions for Link training
- Still in development

CMIS-FF

- CMIS Form Factor
- This Implementation Agreement specifies management control for different modules to provide hardware controls and management in conjunction with CMIS.

CMIS -ELSFP

- CMIS – External Laser Small Form Pluggable
- Implementation Agreement created by the Optical Internetworking Forum for the MIS of External Laser Small From Pluggable Modules.

CMIS Management Functionality

CMIS supports several different types of management functions:

ADVERTISING

- Inventory – Vendor Name, part number, serial number, etc.
- Capabilities – Application capabilities, upgrade capabilities, diagnostic capabilities
- Timing – Initialization times, transition times, etc.

PROVISIONING

- Enabling traffic – Selecting the traffic configuration from the advertised applications
- Setting parameters – i.e. frequency, power, attenuation
- Enabling features – PRBS, loopbacks, etc.

MONITORING

- Alarms
  - Module alarms for temperature, voltage, etc.
  - Signal alarms for Loss of Signal, Loss of lock, etc.
  - Threshold alarms for Versatile Diagnostic Monitoring types
- Performance Monitoring
  - Module Performance Monitoring statistics for temperature, voltage, etc.
  - Versatile Diagnostic Monitoring types

UPGRADES

- Standardized commands to upgrade a CMIS module

How is CMIS implemented?

CMIS is implemented on both the pluggable module and the host. The module and host communicate through a memory-mapped, two-wire interface. The bus is controlled by the host which uses the bus to both control the module and read status from the module. The module responds to bus requests and can initiate communication to the host through fixed-function IO pins, including interrupts and status lines.

The communication bus provides access to 256 bytes of memory. The usage of these 256 bytes is defined within the CMIS specification which supports two memory models. CMIS supports a flat memory model for simpler modules and a paged memory model that extends the 256-byte memory interface into thousands of registers for more advanced modules.

Where is CMIS used?

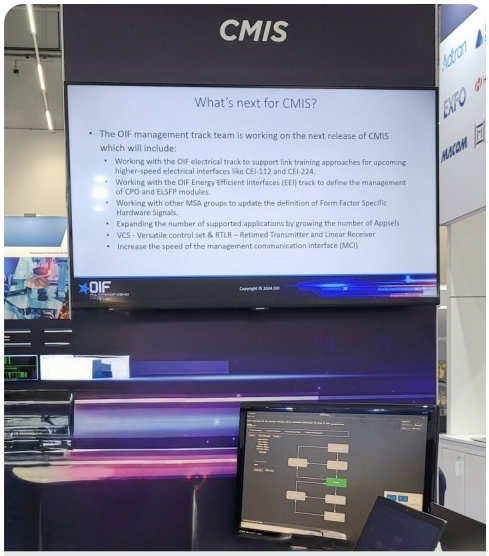
CMIS is used in many applications like data center interconnect. In each case, the CMIS-based pluggable module provides connectivity between two hosts. CMIS provides the management interface for the host to manage the module.

Examples of CMIS-based pluggable modules are passive and active copper cables, AOCs, client/grey optical modules, DWDM modules, Coherent modules, co-packaged optical modules and ELSFP modules.

Examples of host platforms are routers, switches, network interface controllers and blades on optical transport equipment.

What are the benefits of CMIS?

- Re-usable software on both the modules and the hosts
  - The advertising paradigm on which CMIS is based enables the development of a mainly generic host driver and minimizes the need for any software specific to a given module type/technology.
  - Many parts of CMIS are reusable on different CMIS-based modules and hosts.
    - > Upgrade software
    - > State Machine software
    - > Standard alarming
    - > Standard performance monitoring
- Faster module to host integration times through common, proven software
  - Allows the host platforms to develop a generic driver for CMIS-based modules that supports a very wide range of module types/technology with no change to the host platform software.
  - Integration of a new module into an existing host or existing modules into a new host is faster.
- Fewer bugs through common, proven software
  - Re-using and updating existing software into a common software base.
- Specification is adaptable, and it is easy to add new features and new technologies
  - Adding new features and technologies to CMIS is incremental.
- Ability to address multiple protocols
  - PCIe, Ethernet, Fibre Channel, etc



How OIF is Advancing CMIS

OIF is uniquely positioned to support and advance CMIS due to its extensive membership base, encompassing a diverse ecosystem of component manufacturers, module suppliers, host platform developers and network operators. This collaborative environment ensures that CMIS reflects the needs and expertise of the industry.

Additionally, OIF provides best-in-class infrastructure and processes for standards development, enabling the rapid creation, refinement and adoption of specifications that address current challenges while remaining adaptable to future innovations.

Next Steps and Evolution of CMIS

- Technical changes under consideration in OIF's PLL Working Group:
  - Different physical interfaces
    - Adding serial peripheral interface (SPI), and I3C is likely to be added.
    - Electrical specifications are being generated for an Ethernet-based management interface.
  - Object-Based/Message Based
    - Discussion of updating the model from a register-based model to an object-based/message-based model.
    - Allows for faster management interactions, more portable software and feeds better into network management software.
  - Support of next-generation technologies
    - Supporting new projects as they are raised in OIF's optical and electrical tracks.
- Easier useability
  - Path to Plug and Play
    - This is an effort to make modules easier for service providers to use.
    - The **OIF CMIS: Path to Plug and Play white paper** addresses how CMIS 5.3 helps simplify the provisioning of custom modes.
    - More work is expected in this space to reduce integration time and faster adoption of new technology.
  - Interactions with Network Management
    - Using CMIS-based modules in larger networks means better coupling of CMIS to Network Management solutions. The Working Group plans to engage more with the Network Management entities in the coming year.

CMIS and OIF: Driving Standardization and Innovation in Modern Networking

CMIS has become a cornerstone for simplifying and standardizing the management of pluggable media modules across diverse applications and technologies. By addressing the inefficiencies of fragmented management specifications, CMIS provides a unified framework that enhances interoperability, reduces integration time and minimizes the need for custom coding.

As data centers grow more complex and the demand for high-speed connectivity accelerates, CMIS—supported and advanced by OIF—will remain vital in enabling seamless integration, high performance and cost-effective solutions.

Through OIF's stewardship, CMIS will continue to evolve, incorporating new features, addressing emerging challenges and supporting next-generation technologies.

Contact

For more information visit the OIF website:

www.oiforum.com/technical-work/hot-topics/management/

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For public OIF Implementation Agreements, please see Implementation Agreements (IAs):

www.oiforum.com/technical-work/implementation-agreements-ias/