

# OIF

## Versatile Diagnostic Monitoring

CMIS Webinar

Feb 28, 2024

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# Presenter



**Todd Rope,**  
Associate Vice President, Marvell



# Webinar Overview

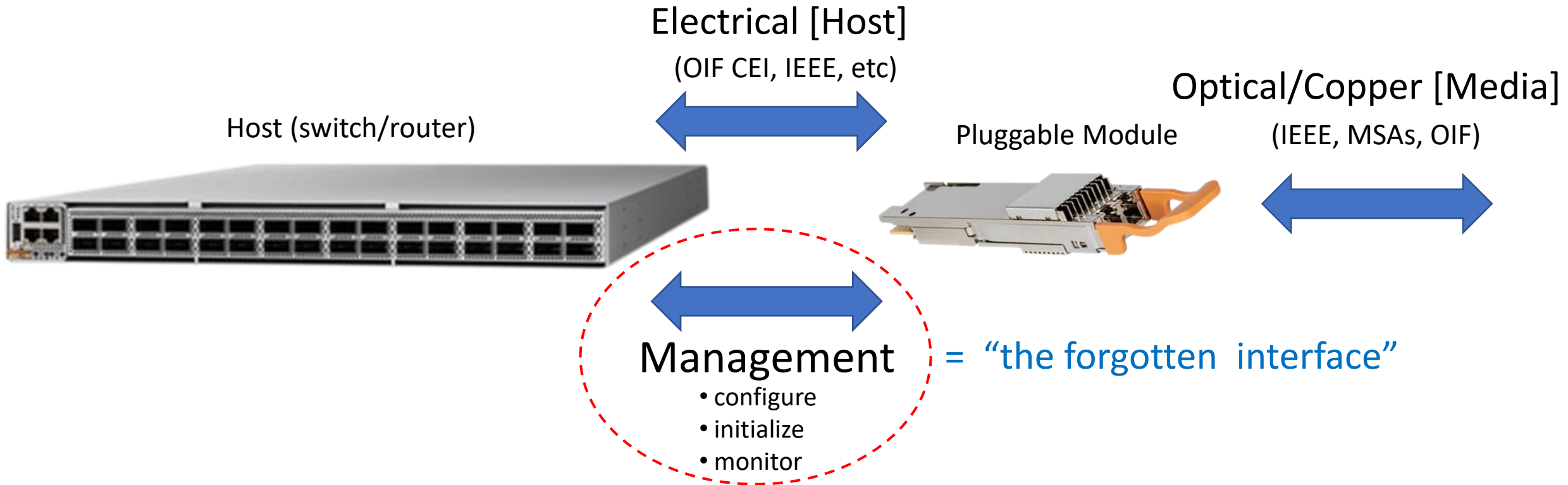
- Review
- A Brief History Lesson
- Why Versatile Diagnostic Monitoring?
- VDM Conceptual Components
- Observables, Statistics, and Intervals
- Advertisement & Construction
- Some Observable Examples
- Interaction with Data Path State Machine
- Q&A



# Prior Webinar: Dec 5, 2023

## Review: What is CMIS ?

**CMIS = Common Management Interface Specification**



# Review: What is CMIS?

Common Management Interface Specification (**CMIS**) is a management interface for optical modules and cable assemblies based on a range of industry form factors such as QSFP-DD and OSFP.

**CMIS** provides a defined set of registers and functions for standard module management including:

- Inventory data
- Module and traffic configuration
- Module monitoring (alarms/defects, performance monitoring)
- Capability advertising

**CMIS** is intended to manage a wide range of range of interconnects such as passive copper cables, 1300 nm client plugs, 400ZR coherent modules, etc.

**CMIS** is written to operate over a two wire interface but can be implemented on other physical interfaces

# Review: How is CMIS structured?

CMIS has grown from a single document to a collection of documents. CMIS is the core and is supported by a set of supplements for specific applications.

- C-CMIS – Coherent CMIS – Provides extensions to CMIS to manage modules with coherent interfaces
- CMIS-FF\* – CMIS Form Factor – Provides details of HW pins and related registers for different module form factors.
- CMIS- ELSFP\* – CMIS External Laser Small Form Factor Pluggable – Provides details for managing Co-Packaging and ELSFP modules.
- CMIS-LT\* – CMIS Link Training – Provides details for managing host side link training on CMIS modules.
- CMIS-VCS\* – CMIS Versatile Control Set – Provides details for managing electrical characteristics of host interfaces.

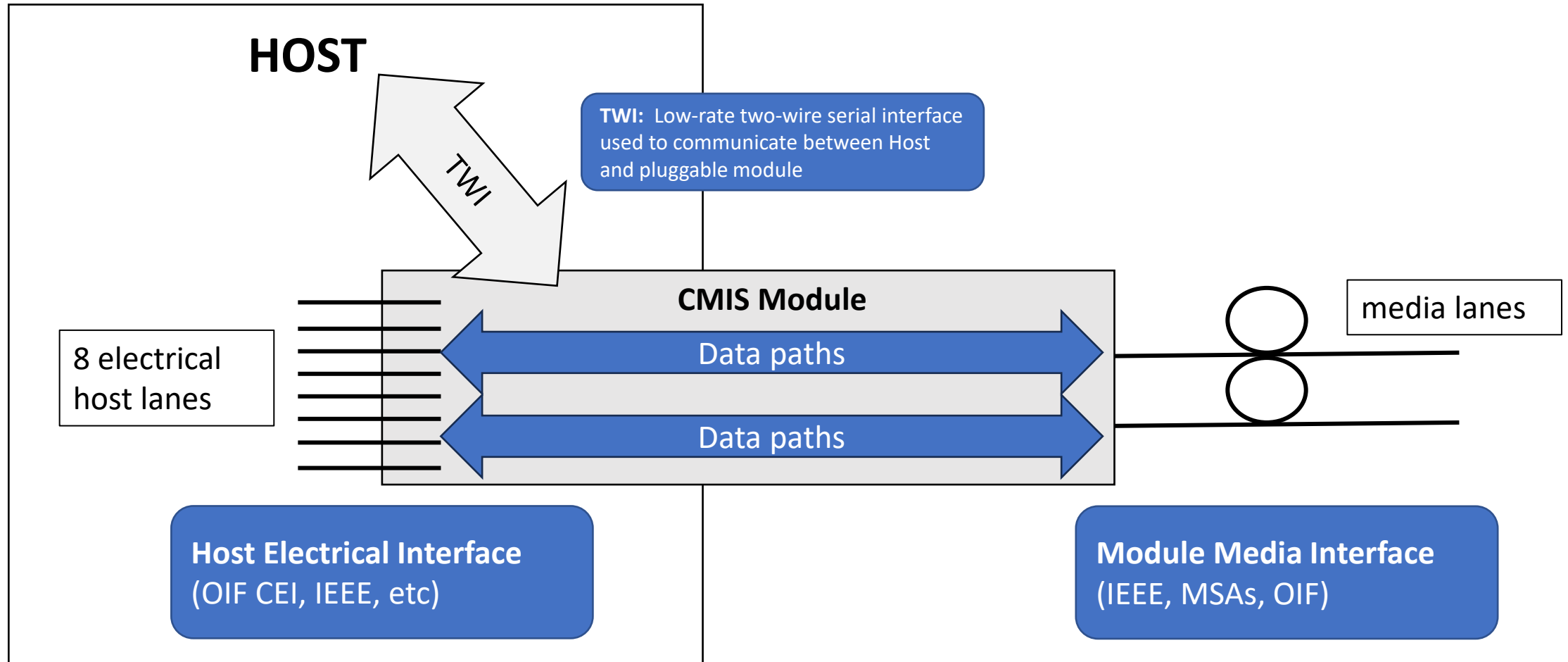
CMIS works in conjunction with other industry standards like SFF-8024 and hardware MSAs.

\*Some CMIS extensions are under development and have not been published yet.



# Prior Webinar: February 7, 2024

## Data Paths (DPSM) and Applications



# Upcoming Webinar: April 3, 2024

- Command Data Block (CDB)/Upgrades
- Presenter: TBD

- OIF Website Link:

<https://www.oiforum.com/meetings-events/cmisis-tutorial-webinar-series/>



# Webinar Overview

- Review
- **A Brief History Lesson**
- Why Versatile Diagnostic Monitoring?
- VDM Conceptual Components
- Observables, Statistics, and Intervals
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# A Brief History Lesson

- Early days (GBIC)
- 

- SFF-8472 (SFP)
- 

- SFF-8636 (QSFP)
- 

- CMIS (QSFP-DD / OSFP / Etc.)

- No monitoring at all!
- 

- Single Lane Supported
  - Configurable Auxiliary Monitoring
- 

- Exactly 4 lanes
  - Basic + Aux Monitoring
  - DSP-based Monitoring Added Later
- 

- Variable Number Of Lanes
- Advertising Of Monitoring Features
- Designed With VDM From Version 3



- Review
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- **Why Versatile Diagnostic Monitoring?**
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# Why Versatile Diagnostic Monitoring

- Each new generation adds new or different capabilities.
- Standards are long-lived documents, especially CMIS!
  
- Many Module Types
- Many Module Vendors
  
- Module Implementation Simplification
- Host Implementation Simplification

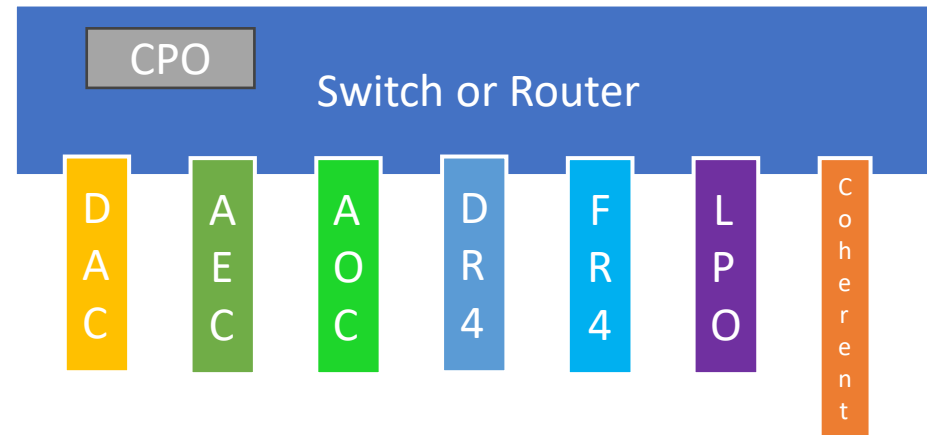


# Why VDM?

## Many Types of Module

Each Type Has Its Own Management:

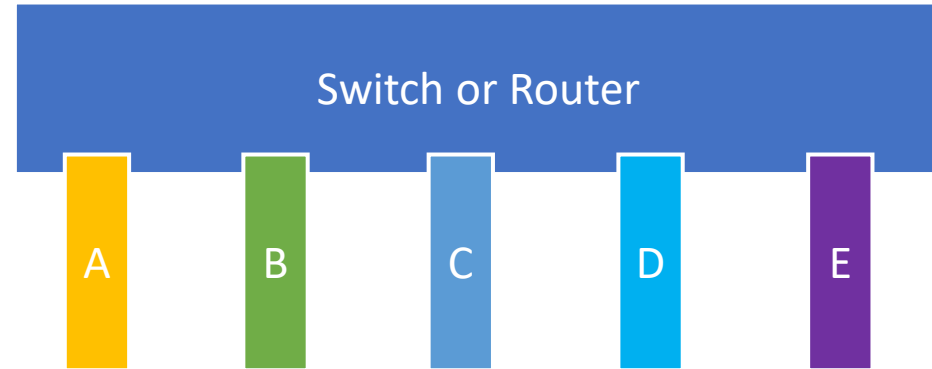
- PAM4?
- DSP?
- Tunable Laser?
- Coherent?
- Many / Few Lanes?
- CPO?



# Why VDM? Many Module Vendors

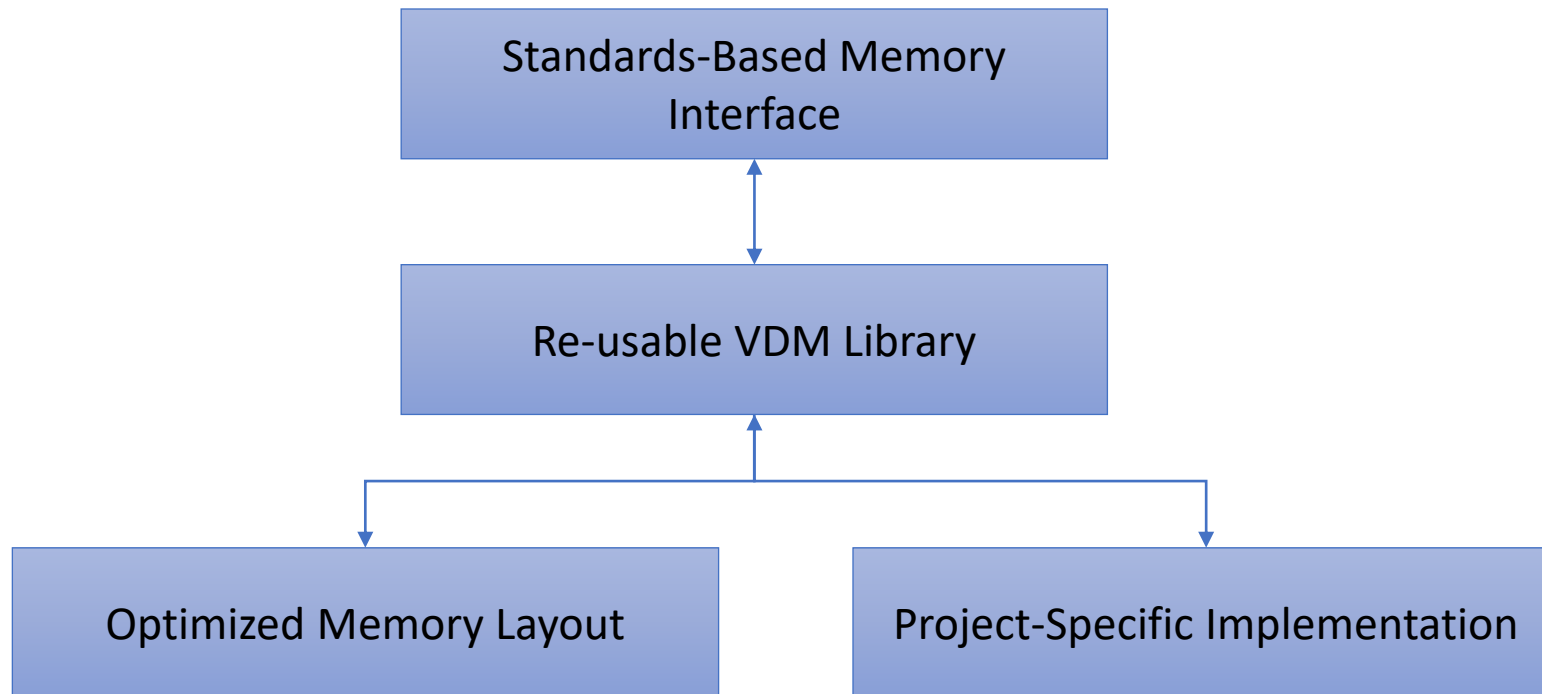
Each Vendor Has Its Own:

- Feature Constraints
- Implementation Constraints
- Memory Constraints



# Why VDM?

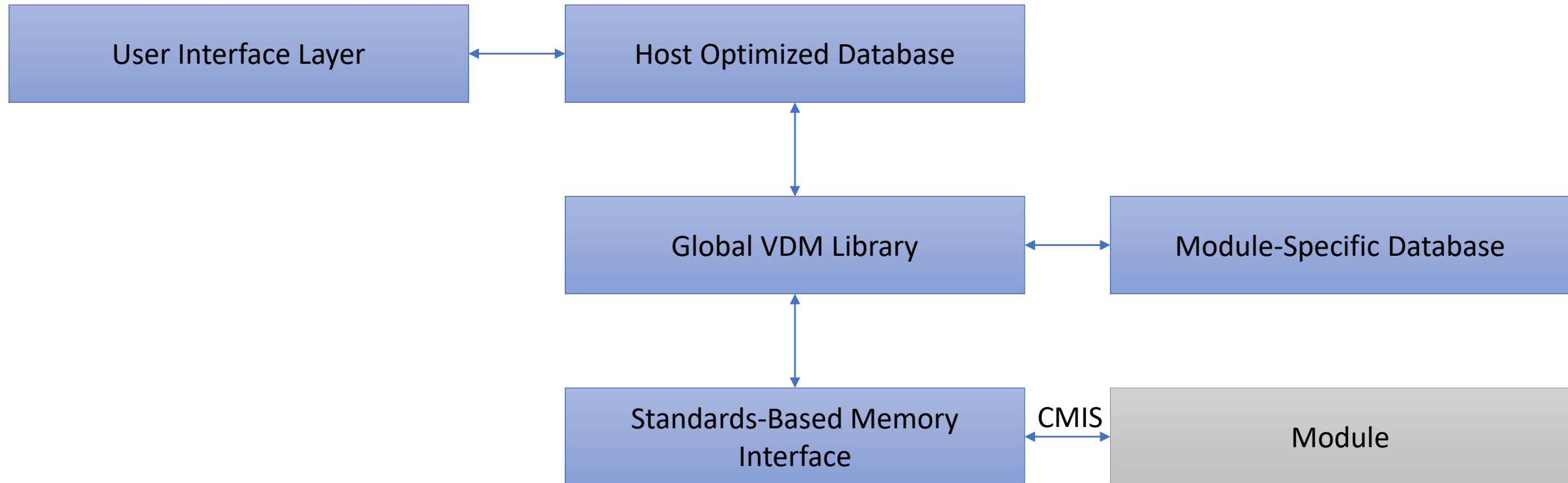
## Simplifying Module Implementations





# Why VDM?

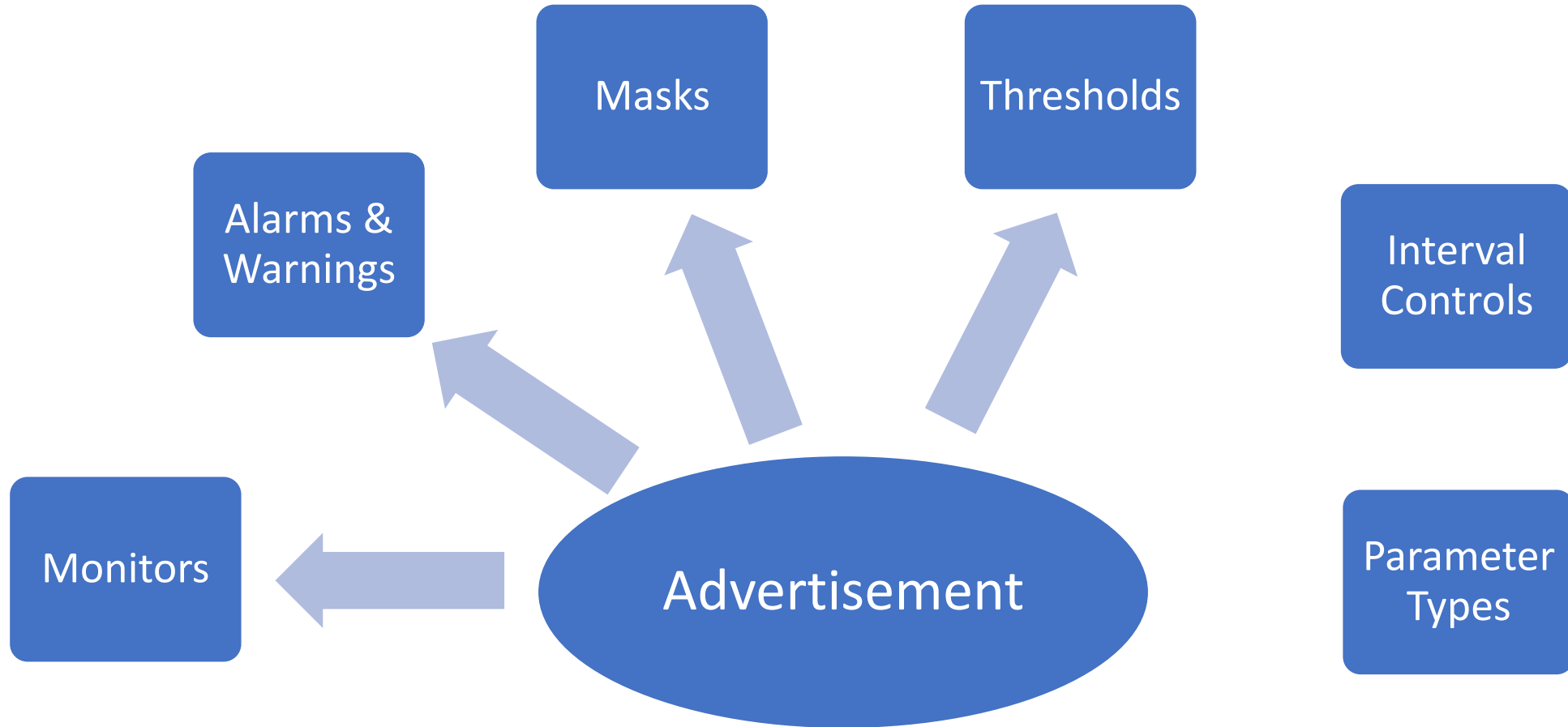
## Simplifying Host Implementations



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- A Brief History Lesson
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- **VDM Conceptual Components**
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# VDM Conceptual Components



# Characteristics of Monitors

- Observable
  - Alarm & Warning Flag Bits
  - Thresholds
  - 2-Byte Data
  - Low & High
  - Masks
  - Same Units As Observable
  - Can Be Shared
- 
- 
- 



# Basic Information – Defined in Standard

- Name, Type & Description
  - Basic / Statistics
- 
- Applicability
  - Module / Lane / Data-Path
- 
- Format
  - Units
  - Increments



# Advertised Information

- Location
- Lane / Data Path Number
- Threshold
- Power Savings Mode
- Where to Find Observable, Alarms
- For Some Parameters
- Where to Find Thresholds
- Host Control Of Power-Intensive VDM Parameters



# Interval Controls

- Control Bits

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- Freeze / Unfreeze

- Acknowledge

- Interval Types

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- Unfrozen / Frozen

- Sampling / Statistics Collection

- Sampling Interval Duration

- Informational

- May Vary Over Time





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# Basic Observables

- Current Value
- No Specified Update Rate in CMIS
  - C-CMIS Specifies 1 Second or Faster
- Threshold-Crossing Indication
- Corresponding Alarm & Warning Flags
- Corresponding Mask Bits
  - Default Value = 1 (Does Not Generate Interrupt)



# Statistics Observables

- Aggregated Data

---

  - Minimum Value

---

  - Maximum Value

---

  - Average Value

---

  - Total Value
- Collected Each Sampling Interval

---

  - Reset On Freeze

---

  - Smallest Sampled Value

---

  - Largest Sampled Value

---

  - Average Over Statistics Collection

---

  - Average of Sampled Values

---

  - Total Accumulated Value



# Sampling Interval

- Module Controlled
- Short Duration
- Typically, 1 mS to 100 mS
- May Vary Over Time
  - Best Effort to Make Constant
- Internal To Module
- Used For Statistics Data Collection
- Module Guarantees No Data Loss

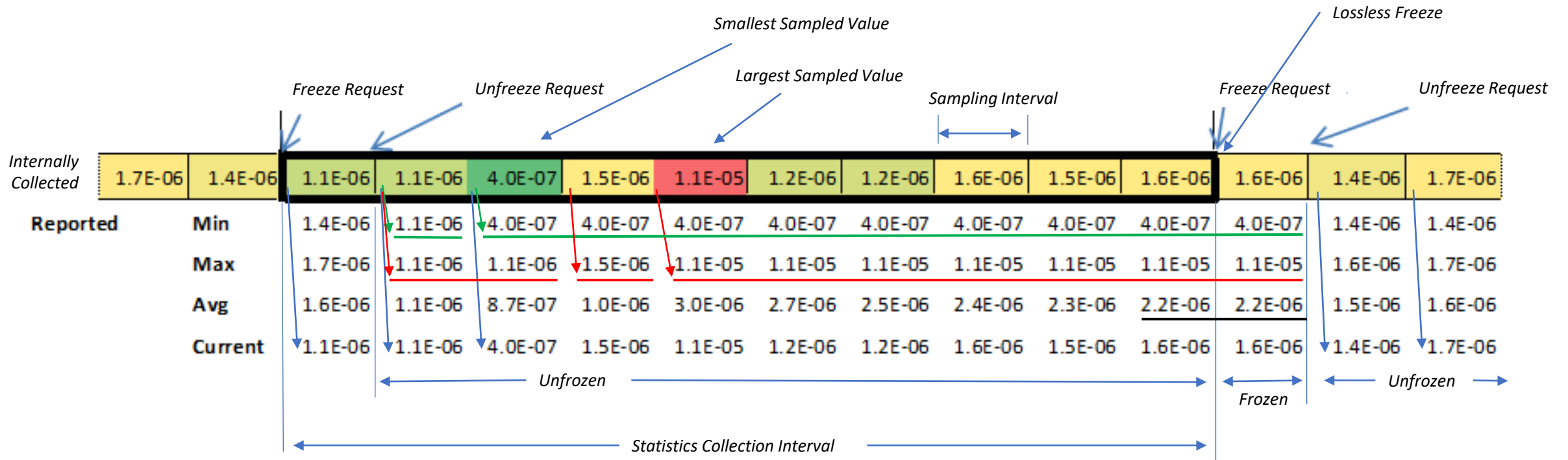


# Statistics Collection Interval

- Host Controlled
  - Driven On Demand
- Longer Duration
  - Typically, 1 Second to 15 Minutes
- Used For Performance Monitoring



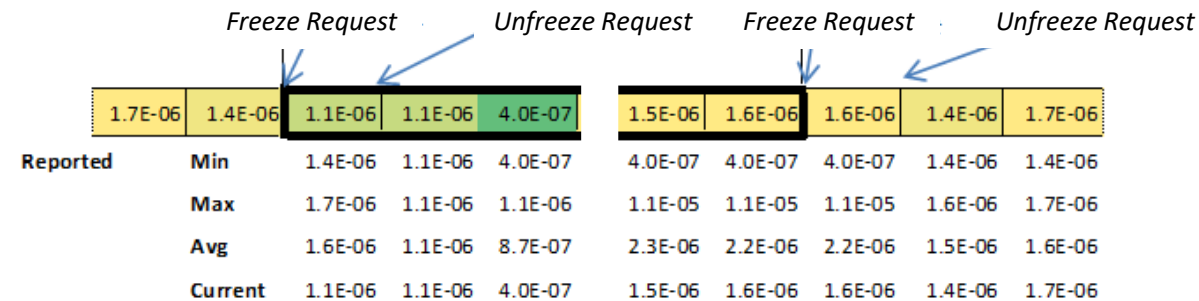
# Performance Monitoring Overview



# Performance Monitoring How-To

## Case 1 – Only Frozen Data Required

1. Host Issues Freeze Request, Starts Statistics Collection Timer
2. Module Executes Lossless Freeze
3. Module Marks Freeze Done
4. Host Checks for Freeze Done
5. Host Reads Frozen Data & Populates Host Database
6. Host Issues Unfreeze Request
7. Module Executes Unfreeze
8. Host Checks for Unfreeze Done
9. Host Statistics Collection Timer Expires  
➔ Repeat From (1)

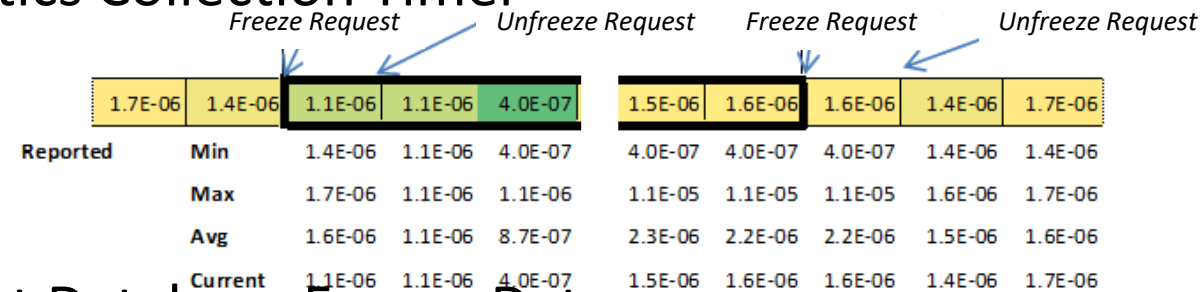




# Performance Monitoring How-To

## Case 2 – Both Frozen and Current Data Required

1. Host Issues Freeze Request, Starts Statistics Collection Timer
2. Module Executes Lossless Freeze
3. Module Marks Freeze Done
4. Host Checks for Freeze Done
5. Host Reads Frozen Data & Populates Host Database **Frozen Data**
6. Host Issues Unfreeze Request
7. Module Executes Unfreeze
8. Host Checks for Unfreeze Done
9. Host Periodically Reads Unfrozen Data & Populates Host Database Unfrozen Data
10. Host Statistics Collection Timer Expires  
➔ Repeat From (1)



# Host Database, Case 2

Module Parameter	Updated By Module When	Host Parameter	Updated By Host When
Current	Each sample	Current	Each host read
Max	Each sample, when unfrozen, if > most recent max	Current Interval Max	Each host read, when unfrozen
Min	Each sample, when unfrozen, if < most recent min	Current Interval Min	Each host read, when unfrozen
Avg	Each sample, when unfrozen	Current Interval Avg	Each host read, when unfrozen
		Prior Interval Max	Once (from Max), when frozen
		Prior Interval Min	Once (from Min), when frozen
		Prior Interval Avg	Once (from Avg), when frozen



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# Global Advertisement

- VDM Support 1h.142.6

---
- VDM Group Support 2Fh.128.1-0

---
- Power Savings Supported 2Fh.128.2

---
- Sampling Interval Length 2Fh.129-130



# Parameter Advertisement

- Group 1 – 20h.128-255
- Group 2 – 21h.128-255
- Group 3 – 22h.128-255
- Group 4 – 23h.128-255

Total of 256 Parameters available in each bank

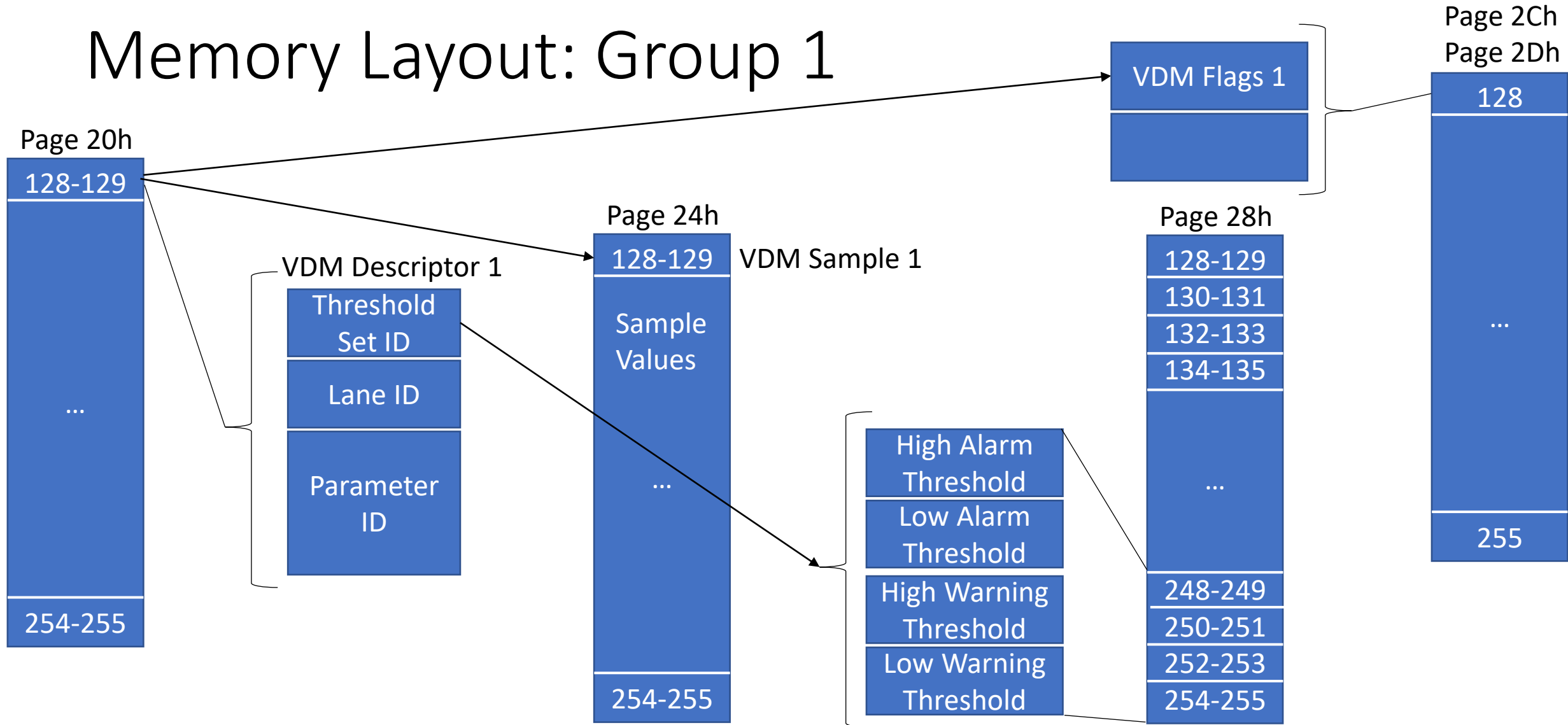
Even Byte		Odd Byte
Bits 7-4	Bits 3-0	Bits 7-0
Threshold Set ID	Lane ID	Parameter

*Relative to Group*

*0 if Module*

*From VDM Parameter List  
Can Be Custom*

# Memory Layout: Group 1



# Example

- Param Descriptor @20h.128-129 →
  - Value: F403
- 20h.128 = F4
  - [7-4]: 15d →
  - [3-0]: 4d →
- 20h.129 = 03
  - 3d →
- VDM Parameter #1
  - Threshold Set #15
    - 28h.248-255
  - Lane #4
    - Applies To Media Lane #4
  - Parameter Type #3
    - Laser Frequency Monitor





# Interval Controls

- Freeze Request

---

0 → 1

- Unfreeze Request

---

1 → 0

- Freeze Done

---

- 2Fh.145.7

- Unfreeze Done

- 2Fh.145.6

# Banking Support

- VDM Parameters Support Banking
- Lane ID's Are 8-lane bank
  - E.g., Bank ID 1 supports Lanes 9-16
- Freeze/Unfreeze: Global Across All Banks



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# Laser Frequency Error

- Report error in actual output laser frequency relative to programmed frequency

Content	Value
Type ID	3
Lane Dependence	Media
Instance Type	Basic
Data Type	S16
Unit Scale	10
Unit	MHz



# PAM4 Histogram SNR & LTP

**SNR** SNR (dB) :=  $10 * \log_{10}( \min\{ \text{SNR}_0, \text{SNR}_1, \text{SNR}_2 \} )$

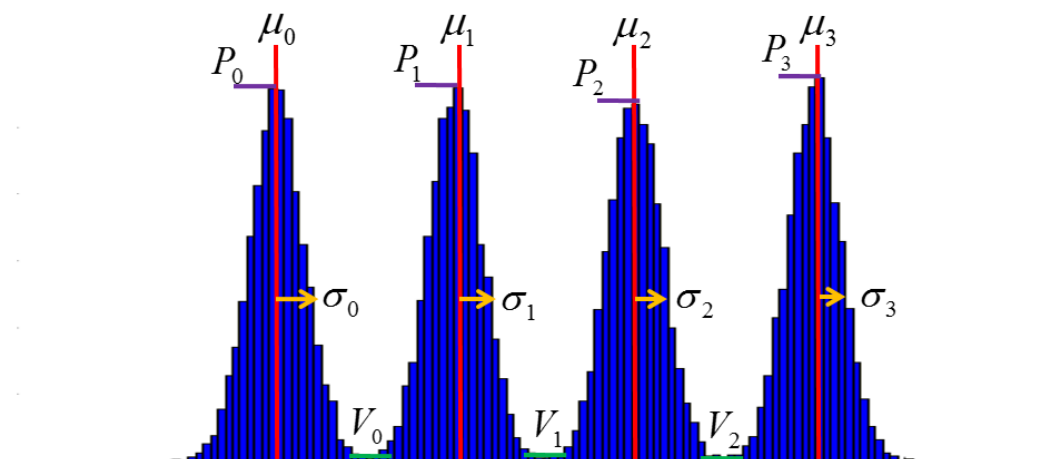
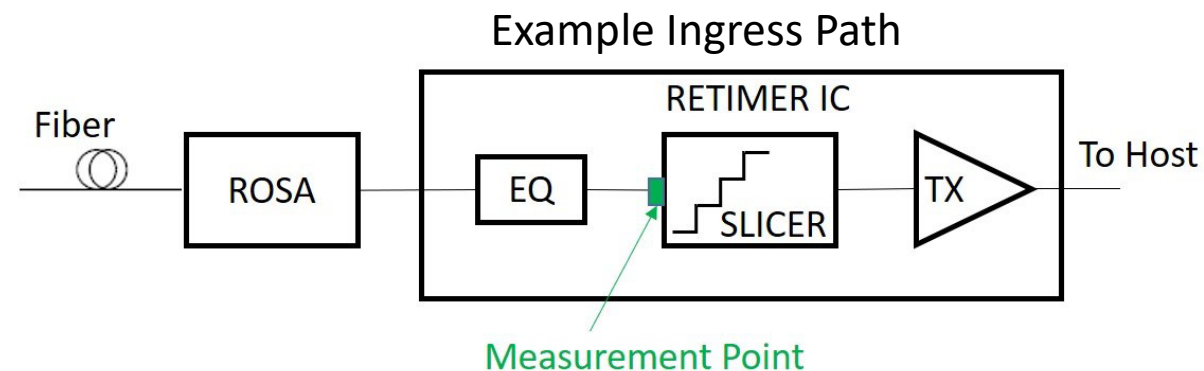
where for an **optical** lane  $\text{SNR}_i := (\mu_{i+1} - \mu_i) / (\sigma_{i+1} + \sigma_i)$

and for an **electrical** lane  $\text{SNR}_i := 1/2 \cdot (\mu_{i+1} - \mu_i)^2 / (\sigma_{i+1}^2 + \sigma_i^2)$

**LTP** LTP (dB) :=  $10 * \log_{10}( \min\{ \text{LTP}_0, \text{LTP}_1, \text{LTP}_2 \} )$

where  $\text{LTP}_i := (P_{i+1} + P_i) / (2V_i)$

Content	Value
Type ID	5,6,7,8
Lane Dependence	Media / Host
Instance Type	Basic
Data Type	U16
Unit Scale	1/256
Unit	dB



$V_i$  and  $P_i$  measured on histogram Y-axis  
 $\mu_i$  and  $\sigma_i$  measured on histogram X-axis

# Pre-FEC Bit Error Ratio

- Reports Bit Error Ratio
- Used for Performance Monitoring
- Basic Parameter
  - Current
- Statistics Parameter
  - Min / Max / Avg BER
- Host or Media Data Path

Content	Value
Type ID	9-16
Lane Dependence	Media / Host
Instance Type	Basic / Statistics
Data Type	F16
Unit Scale	-
Unit	Unitless



# Frame Error Counter

- Reports Frame Error Counters
  - Adjusted for FEC codeword size
- Used for Performance Monitoring
- Basic Parameter
  - Current
- Statistics Parameter
  - Min / Max / Avg / Total
- Host or Media Data Path

Content	Value
Type ID	17-26
Lane Dependence	Media / Host
Instance Type	Basic / Statistics
Data Type	F16
Unit Scale	-
Unit	Unitless



# Coherent CMIS Examples

- Defined in C-CMIS
- Many Optical Parameters:
  - Modulator Bias
  - Chromatic Dispersion
  - Differential Group Delay
  - Polarization Dependent Loss
  - Optical SNR
  - Carrier Frequency Offset
  - Q-factor
  - Etc.





# Co-Packaged Optics Voltage Monitors

- Coming in CMIS 5.3
- For Monitoring Multiple Supply Voltages in CPO
  - 2.6 Volt
  - 1.8 Volt
  - 1.2 Volt
  - 0.9 Volt
  - 0.7 Volt
  - 12 Volt

Content	Value
Type ID	77-83
Lane Dependence	Module
Instance Type	Basic
Data Type	U16
Unit Scale	100 or 250 (12V monitor)
Unit	$\mu\text{V}$



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# Interaction With DPSM

- Alarm And Warning Conformance Rules
  - Some Params Not Appropriate For Some DPSM States
  - See Table 6-22
  - See Also C-CMIS Table 7
- VDM monitor behavior during 'off' states
  - Market-driven. Standard doesn't specify

Table 6-22 VDM Flag Conformance Rules

VDM Observable Type	DPDeactivated	DPInitialized	DPInit	DPDeinit	DPTxTurnOn DPTxTurnOff DPAactivated
Laser Age	N/A	allowed	allowed	allowed	allowed
TEC Current	allowed	allowed	allowed	allowed	allowed
Laser Frequency Error	N/A	allowed	allowed	allowed	allowed
Laser Temperature	N/A	allowed	allowed	allowed	allowed
SNR Media Tunit	allowed	allowed	allowed	allowed	allowed



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Thank You

