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Disk Drive Diagnostics Profile

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Foreword

The *Disk Drive Diagnostics Profile* (DSP1113) was prepared by the Diagnostics Working Group of the DMTF.

DMTF is a not-for-profit association of industry members dedicated to promoting enterprise and systems management and interoperability. For information about the DMTF, see http://www.dmtf.org.

Acknowledgments

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Introduction

A *profile* is a collection of Common Information Model (CIM) elements and behavior rules that represent a specific area of management. The purpose of the profile is to ensure interoperability of web-based enterprise management (WBEM) services for a specific subset of the CIM schema — in this case Disk Drive diagnostics.

Diagnostics is a critical component of systems management. Diagnostic services are used in problem containment to maintain availability, achieve fault isolation for system recovery, establish system integrity during boot, increase system reliability, and perform routine proactive system verification. The goal of the Common Diagnostic Model (CDM) is to define industry-standard building blocks, based on and consistent with the DMTF CIM, which enables seamless integration of vendor-supplied diagnostic services into system and SAN management frameworks.

The goal of the *Disk Drive Diagnostics Profile* is to define industry-standard building blocks that enable seamless problem determination support for Disk Drives and to troubleshoot network problems involving Disk Drives. The *Disk Drive Diagnostics Profile* extends the standard diagnostic profile by identifying a base set of Disk Drive functions that should be diagnosed by provider implementations. Suppliers can differentiate their diagnostic offering by providing this base set of diagnostics and developing diagnostics to analyze proprietary features of the Disk Drive.

Document conventions

Typographical conventions

The following typographical conventions are used in this document:

- Document titles are marked in *italics*.
- Important terms that are used for the first time are marked in *italics*.

ABNF usage conventions

Format definitions in this document are specified using ABNF (see RFC5234), with the following deviations:

- Literal strings are to be interpreted as case-sensitive Unicode characters, as opposed to the definition in RFC5234 that interprets literal strings as case-insensitive US-ASCII characters.

153 # Disk Drive Diagnostics Profile

154 ## 1 Scope

155 The *Disk Drive Diagnostics Profile* specializes the *Diagnostics Profile* by defining the set of classes,
156 properties, methods and default values needed to perform effective problem determination for Disk Drives
157 within a management domain.

158 The target audience for this specification includes implementers who are writing CIM-based Disk Drive
159 diagnostics or consumers of CIM-based diagnostics for the Disk Drive.

160 ## 2 Normative references

161 The following referenced documents are indispensable for the application of this document. For dated or
162 versioned references, only the edition cited (including any corrigenda or DMTF update versions) applies.
163 For references without a date or version, the latest published edition of the referenced document
164 (including any corrigenda or DMTF update versions) applies.
165

166 DMTF DSP0004, *CIM Infrastructure Specification 2.6*,
167 http://dmtf.org/sites/default/files/standards/documents/DSP0004_2.6.pdf

168 DMTF DSP0200, *CIM Operations over HTTP 1.3*,
169 http://dmtf.org/sites/default/files/standards/documents/DSP0200_1.3.pdf

170 DMTF DSP1001, *Management Profile Specification Usage Guide 1.0*,
171 http://dmtf.org/sites/default/files/standards/documents/DSP1001_1.0.pdf

172 DMTF DSP1002, *Diagnostics Profile Specification 2.0*,
173 http://dmtf.org/sites/default/files/standards/documents/DSP1002_2.0.pdf

174 DMTF DSP1033, *Profile Registration Profile 1.0*,
175 http://dmtf.org/sites/default/files/standards/documents/DSP1033_1.0.pdf

176 DMTF DSP1114, *RAID Controller Diagnostics 1.0.0a*,
177 http://dmtf.org/sites/default/files/standards/documents/DSP1114_1.0.0a.pdf

178 INCITS, Technical Committee T10, *Small Computer System Interface (SCSI)*,
179 http://www.t10.org/

180 INCITS, Technical Committee T13, *AT Attachment (ATA) Storage Interface*,
181 http://www.t13.org/

182 IETF RFC5234, *ABNF: Augmented BNF for Syntax Specifications, January 2008*,
183 http://tools.ietf.org/html/rfc5234

184 ISO/IEC Directives, Part 2, *Rules for the structure and drafting of International Standards,*
185 http://isotc.iso.org/livelink/livelink.exe?func=ll&objId=4230456&objAction=browse&sort=subtype

186 Serial ATA, *Serial ATA (SATA) Storage Interface,*http://www.serialata.org/

187

SNIA, *Storage Management Initiative Specification (SMI-S) 1.4,*
http://www.snia.org/tech_activities/standards/curr_standards/smi/

3 Terms and definitions

In this document, some terms have a specific meaning beyond the normal English meaning. Those terms are defined in this clause.

The terms "shall" ("required"), "shall not," "should" ("recommended"), "should not" ("not recommended"), "may," "need not" ("not required"), "can" and "cannot" in this document are to be interpreted as described in ISO/IEC Directives, Part 2, Annex H. The terms in parenthesis are alternatives for the preceding term, for use in exceptional cases when the preceding term cannot be used for linguistic reasons. Note that in ISO/IEC Directives, Part 2, Annex H specifies additional alternatives. Occurrences of such additional alternatives shall be interpreted in their normal English meaning.

The terms "clause," "subclause," "paragraph," and "annex" in this document are to be interpreted as described in ISO/IEC Directives, Part 2, Clause 5.

The terms "normative" and "informative" in this document are to be interpreted as described in ISO/IEC Directives, Part 2, Clause 3. In this document, clauses, subclauses, or annexes labeled "(informative)" do not contain normative content. Notes and examples are always informative elements.

The terms defined in DSP0004, DSP0200, and DSP1001 apply to this document.

4 Symbols and abbreviated terms

The following symbols and abbreviations are used in this document.

4.1
ATA
AT Attachment Storage Interface

4.2
CDM
Common Diagnostic Model

4.3
CIM
Common Information Model

4.4
CIMOM
CIM Object Manager

4.5
CRU
Customer Replaceable Unit

4.6
FRU
Field Replaceable Unit

4.7
HDD
Hard Disk Drive

4.8
LBA
Logical Block Addressing

4.9
ME
Managed Element

4.10
MOF
Managed Object Format

4.11
OS
Operating System

4.12
PD
Problem Determination

4.13
PFA
Predictive Failure Analysis

4.14
POST
Power-On Self-Test

4.15
QA
Quality Assurance

4.16
RAID
Redundant Array of Independent Disks

4.17
SAN
Storage Area Network

4.18
SATA
Serial Advanced Technology Attachment

4.19
SCSI
Small Computer System Interface

4.20
S.M.A.R.T.
Self-Monitoring, Analysis, and Reporting Technology

4.21
SSD
Solid State Drive

4.22
WBEM
Web-Based Enterprise Management

5 Synopsis

Profile Name: Disk Drive Diagnostics

Version: 1.0.0

Organization: DMTF

CIM schema version: 2.29

Central Class: CIM_DiskDriveDiagnosticTest

Scoping Class: CIM_ComputerSystem

Specializes: Diagnostic Profile 2.0.0

The *Disk Drive Diagnostics Profile* extends the management capability of referencing profiles by adding common methods for determining that the Disk Drive is operating normally in a managed system.

CIM_DiagnosticTest shall be the Central Class of this profile. The instance of CIM_DiagnosticTest shall be the Central Instance of this profile. CIM_ComputerSystem shall be the Scoping Class of this profile. The instance of CIM_ComputerSystem with which the Central Instance is associated through an instance of CIM_HostedService shall be the Scoping Instance of this profile.

The CIM_ManagedElement is CIM_DiskDrive or a subclass of it.

NOTE: When the physical drive is part of a RAID configuration, please refer to the RAID Controller Diagnostics Profile.

Table 1 identifies profiles on which this profile has a dependency.

Table 1 – Referenced profiles

Profile name	Organization	Version	Description
Diagnostics	DMTF	2.0	Specializes
Profile Registration	DMTF	1.0	Mandatory
Disk Drive Lite	SNIA	1.3.0	Optional

6 Description

Diagnostic programs can be developed to verify that the Disk Drive is behaving properly, to identify its faulty components or to diagnose any components. Such tests are run in two distinct environments: 1) at

298 a vendor facility during development or manufacturing as part of their QA process, or 2) at an end-user
299 location. In end-user environments, certain diagnostic tests will not be practical to run because they might
300 modify or destroy data or they might take too long to run.
301 This specification attempts to cover a range of disk drive technologies and interfaces (for example, ATA,
302 SATA, SCSI, SSD, etc.), although some defined tests may only apply to certain technologies. For
303 example, the disk vendor industry has defined a set of tests for ATA interface drives called Self-
304 Monitoring, Analysis, and Reporting Technology (S.M.A.R.T.).

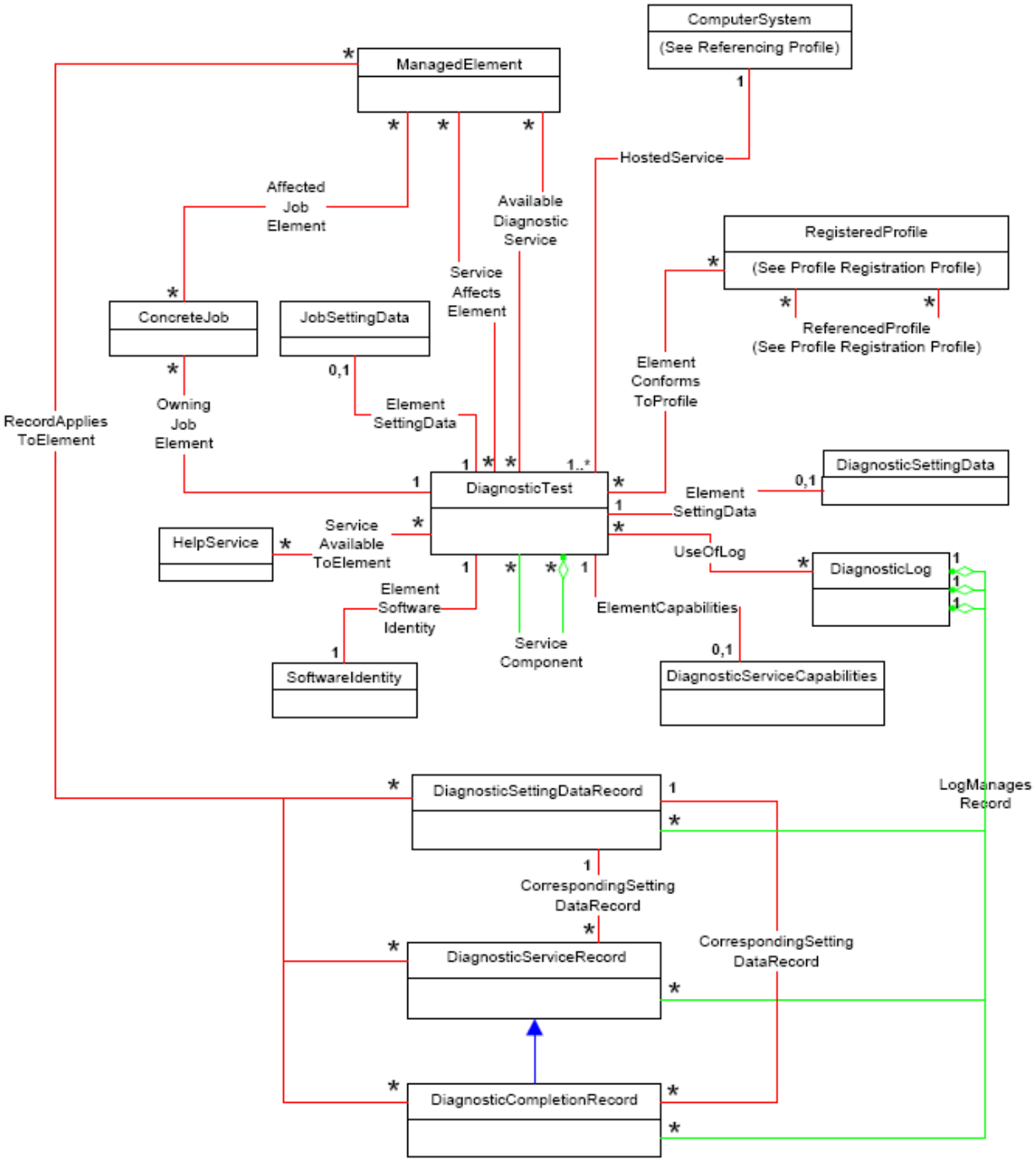

Figure 1 – Disk Drive Diagnostics Profile: Profile class diagram

7 Implementation

This clause details the requirements related to the arrangement of instances and their properties for implementations of this profile.

7.1 Disk drive test information

Table 2 provides general information for each test type.

Table 2 – Test type information

Test Name	Test Information	
Short Self-Test	**Coverage Area**	The diagnostic performs a small set of vendor-specific tests to verify that the disk is operating properly.
	Coverage Range	The entire disk drive is covered.
	User Control	None
	Execution Time	The diagnostic runs on order of seconds.
	Built into Device	Yes
	Details	For SCSI, a Self-Test is initiated using a Send Diagnostic command (operation code = 1D) while the results of the Self-Test are retrieved using a Receive Diagnostics Results command (operation code = 1C) A drive may support vendor-specific internal self-tests. The test results are written to a self-test log.
Extended Self-Test	**Coverage Area**	The diagnostic performs an extended set of vendor-specific tests to verify that the disk is operating properly.
	Coverage Range	The entire disk drive is covered.
	User Control	The user may also specify that the extended self-test run for a specified period of time using CIM_DiskDriveDiagnosticSettingData.LoopControl = 4 (Timer) and CIM_DiskDriveDiagnosticSettingData.LoopControlParameter
	Execution Time	The diagnostic runs on order of minutes to hours depending upon the capacity and disk speed.
	Built into Device	Yes
	Details	If a time duration is specified, the diagnostic simply stops at whatever test in the set of self-tests it happens to be running at the time.
Selected Self-Test	**Coverage Area**	The diagnostic performs an extended set of vendor-specific tests to verify that the disk is operating properly, but limited to a specific range of the disk.
	Coverage Range	The selected LBA range is covered.
	User Control	The user may specify a selected LBA range
	Execution Time	The diagnostic runs on order of minutes to hours depending upon the region selected and disk speed.
	Built into Device	Yes
	Details	All of the tests of the extended self-test are run but only against the selected LBA range
Sequential Read	**Coverage Area**	This diagnostic performs a read operation from disk sectors in sequential order for a selected LBA range
	Coverage Range	The selected LBA range is covered.
	User Control	The user may specify the LBA range and the size of data to be transferred for each read operation.
	Execution Time	The diagnostic runs on order of minutes to hours depending upon the region selected and disk speed.

Test Name	Test Information	
	Built into Device	Yes
	Details	Data is transferred from disk to host.
Random Read	**Coverage Area**	This diagnostic performs a read operation from disk sectors in random order within a selected LBA range.
	Coverage Range	The selected LBA range is covered.
	User Control	The user may specify the seed to use and the size of data to be transferred for each read operation.
	Execution Time	The diagnostic runs on order of minutes to hours depending upon the region selected and disk speed.
	Built into Device	Yes
	Details	Data is transferred from disk to host.
Sequential Read-Write-Read Compare	**Coverage Area**	This diagnostic verifies that the read and write operations are performed properly for a selected LBA range. Disk sectors are tested in sequential order.
	Coverage Range	The selected LBA range is covered.
	User Control	The user may specify an LBA range to be tested and the size of the data to be transferred.
	Execution Time	The diagnostic runs on order of minutes to hours depending upon the selected LBA range, the size of I/O operations to perform, and disk speed.
	Built into Device	Yes
	Details	The diagnostic reads a block and then writes the read data back to the block. The diagnostic then reads data a second time and verifies that the data has not changed. Because data might be modified unintentionally by an errant write operation, CIM_DiskDriveDiagnosticTest.Characteristics shall include 5 (Is Risky). Data is transferred to/from host and disk.
Random Read-Write-Read Compare	**Coverage Area**	This diagnostic verifies that read and write operations are performed properly for a selected LBA range. Disk sectors are tested in random order.
	Coverage Range	The selected LBA range is covered.
	User Control	The user may specify an LBA range, the data transfer size and the seed.
	Execution Time	The diagnostic runs on order of minutes to hours depending upon the region selected and disk speed.
	Built into Device	Yes
	Details	The diagnostic reads a block and then writes the read data back to the block. The diagnostic then reads data a second time and verifies that the data has not changed. Because data might be modified unintentionally by an errant write operation, DiagnosticTest.Characteristics shall include 5 (Is Risky). Data is transferred to/from host and disk.
Sequential Internal Verify	**Coverage Area**	This diagnostic verifies the ability to perform read and verify operations from track to track and head to head in sequential order.
	Coverage Range	The entire disk drive is covered.

Test Name	Test Information	
	User Control	None
	Execution Time	The diagnostic runs on order of minutes to hours but depends upon disk capacity and disk speed.
	Built into Device	Yes
	Details	Data is not transferred from disk to host; that is, this test is internal to the disk.
Status	**Coverage Area**	This diagnostic returns information about the relative health of the disk drive based upon internal analysis of failure statistics
	Coverage Range	The entire disk drive is covered.
	User Control	None
	Execution Time	The diagnostic returns immediately.
	Built into Device	Yes
	Details	Analysis of failure statistics is performed by the disk drive, not by the diagnostic test, which simply returns an overall status value.
Grown Defect	**Coverage Area**	The diagnostic retrieves statistics (such as the number of remapped sectors) collected by the disk drive regarding its sector remap mechanism.
	Coverage Range	The entire disk drive is covered.
	User Control	None
	Execution Time	The diagnostic returns immediately.
	Built into Device	Yes
	Details	For SCSI drives, the Read Defect Data command (B7) might be used. For SATA drivers, the S.M.A.R.T. Reallocated Sector Count (ID = 5) command might be used.
4K Alignment	**Coverage Area**	For disk drives that support this feature, the diagnostic verifies that blocks can be properly aligned on 4K boundaries.
	Coverage Range	The entire disk drive is covered.
	User Control	None
	Execution Time	The diagnostic runs on order of seconds.
	Built into Device	Yes
	Details	
Power Management	**Coverage Area**	The diagnostic verifies that disk power management features can be set and that they operate properly; for example, standby, sleep, lower power idle, etc.
	Coverage Range	The entire disk drive is covered.
	User Control	None.
	Execution Time	The diagnostic runs on order of minutes.
	Built into Device	Yes.
	Details	

Test Name	Test Information	
Performance	**Coverage Area**	The diagnostic verifies that the disk operates within the vendor/product specific performance ranges for read operation transfer rates, sequential seek times and random seek times.
	Coverage Range	The entire disk drive is covered.
	User Control	The user may select the data transfer size.
	Execution Time	The diagnostic runs on the order of hours depending upon the disk capacity and disk speed.
	Built into Device	Yes
	Details	

7.2 CIM_DiskDriveDiagnosticTest

The CIM_DiskDriveDiagnosticTest can be used for a variety of tests necessary for diagnosing Disk Drive issues. Table 3 defines the valid property values and whether or not the test is mandatory or optional. An implementation may extend this class and add vendor-defined tests using the vendor-defined range of the DiskDriveTestType valuemap.

The current values for TestType array property are: 0 (Unknown), 1 (Other), 2 (Functional), 3 (Stress), 4 (Health Check), 5 (Access Test), 6 (Media Verify), 7 (DMTF Reserved), 8 (Vendor Reserved).

Table 3 – CIM_DiskDriveDiagnosticTest property requirements

Test Name	Criteria	ElementName *	DiskDriveTestType	TestType *
Short Self-Test	Mandatory	Disk Drive Short Self-Test	2	2 (Functional) 6 (Media Verify)
Extended Self-Test	Optional	Disk Drive Extended Self-Test	3	2 (Functional) 6 (Media Verify)
Selective Self-Test	Optional	Disk Drive Selective Self-Test	4	2 (Functional) 6 (Media Verify)
Sequential Read	Mandatory	Disk Drive Sequential Read	5	2 (Functional) 6 (Media Verify)
Random Read	Optional	Disk Drive Random Read	6	2 (Functional) 6 (Media Verify)
Sequential Read-Write-Read Compare	Mandatory	Disk Drive Sequential Read-Write-Read Compare	7	2 (Functional) 6 (Media Verify)
Random Read-Write-Read Compare	Optional	Disk Drive Random Read-Write-Read Compare	8	2 (Functional) 6 (Media Verify)
Sequential Internal Verify	Optional	Disk Drive Sequential Internal Verify	9	2 (Functional) 6 (Media Verify)

321

Status	Mandatory	Disk Drive Status	10	4 (Health Check)
Grown Defects	Optional	Disk Drive Grown Defects	11	2 (Functional)
4K Alignment	Optional	Disk Drive 4K Alignment	12	2 (Functional)
Power Management	Optional	Disk Drive Power Management	13	2 (Functional)
Performance	Optional	Disk Drive Performance	14	2 (Functional) 6 (Stress)

322 An asterisk (*) indicates that the property is inherited from the parent class CIM_DiagnosticTest.

323 The current values for the Characteristics array property inherited from the CIM_DiagnosticTest parent
324 class are: 0 (Unknown), 1 (Other), 2 (Is Exclusive), 3 (Is Interactive), 4 (Is Destructive), 5 (Is Risky), 6 (Is
325 Package), 7 (Reserved), 8 (Is Synchronous), 9 (Media Required), 10 (Additional Hardware Required).
326 The OtherCharacteristicsDescription property is used to provide additional information about the nature of
327 the test. The content of the OtherCharacteristicsDescription property is vendor-specific.

328 **Table 4 – CIM_DiskDriveDiagnosticTest property requirements**

Test Name	Characteristics*	OtherCharacteristicsDescriptions*	Comment
Short Self-Test			
Extended Self-Test			
Selective Self-Test			
Sequential Read	5(Is Risky)		
Random Read	5(Is Risky)		
Sequential Read-Write-Read Compare	4 (Is Destructive) 5(Is Risky)		
Random Read-Write-Read Compare	4 (Is Destructive) 5(Is Risky)		
Sequential Internal Verify	4 (Is Destructive) 5(Is Risky)		
Status			
Grown Defects			
4K Alignment			
Power Management			
Performance			

329 An asterisk (*) indicates that the property is inherited from the parent class CIM_DiagnosticTest.

330 7.3 CIM_DiskDriveDiagnosticSettingData

331 A diagnostic test may require parameters to run. Some parameters may affect how the test is run while
332 other parameters provide the values to be used by the test.

333 CIM_DiagnosticSettingData contains properties that affect how a diagnostic test is run (for example,
334 LoopControl, QuickMOde), how errors are handled (for example, HaltOnError), or how results are logged

(for example, LogOptions). CIM_DiagnosticSettingData is an argument to the CIM_DiagnosticTest.RunDiagnosticService( ) extrinsic method. If additional properties are needed that control the behavior of the diagnostic test, they should be defined in a subclass of CIM_DiagnosticSettingData.

The CIM_DiskDriveDiagnosticSettingData class defines additional parameters that may be used by some of the disk drive tests. Table 5 lists these test parameters and shows which tests might use them. An implementation may extend this class and define additional parameters for any vendor-defined tests.

Table 5 – **CIM_DiskDriveDiagnosticSettingData property requirements**

Test Name	ElementName*	LBA Start	LBA End	Seed	Data Sizes	Data Patterns
Short Self-Test	Disk Drive Short Self					
Extended Self-Test	Disk Drive Extended Self					
Selective Self-Test	Disk Drive Region Self	Used	Used			
Sequential Read	Disk Drive Sequential Read	Used	Used		Used	
Random Read	Disk Drive Random Read	Used	Used	Used	Used	
Sequential Read-Write-Read Compare	Disk Drive Sequential Read-Write-Read Compare	Used	Used		Used	Used
Random Read-Write-Read Compare	Disk Drive Random Read-Write-Read Compare	Used	Used	Used	Used	Used
Sequential Internal Verify	Disk Drive Sequential Internal Verify	Used	Used			
Status	Disk Drive Status					
Grown Defect	Disk Drive Grown Defect					
4K Alignment	Disk Drive 4K Alignment					
Power Management	Disk Drive Power Management					
Performance	Disk Drive Performance				Used	

An asterisk (*) indicates that the property is inherited from the parent class CIM_DiagnosticSettingData.

If any CIM_DiskDriveDiagnosticSettingData property does not have a value when passed as an argument to the CIM_DiagnosticTest.RunDiagnosticService( ) extrinsic method, the default values for the test arguments shall be used. The default values are defined by the test implementer.

7.3.1 CIM_DiskDriveDiagnosticSettingData.LBAStart

This property is used by a client to specify the start of a region to be test. If LBAStart is NULL, the default value of 0 is used. To specify the entire disk, both LBAStart and LBAEnd shall be NULL.

7.3.2 CIM_DiskDriveDiagnosticSettingData.LBAEnd

This property is used by a client to specify the end of a region to be test. If LBAEnd is NULL, the default value is the number of the last disk sector. To specify the entire disk, both LBAStart and LBAEnd shall be NULL.

7.3.3 CIM_DiskDriveDiagnosticSettingData.Seed

This property is used by a client to specify the seed that initiates the random number sequence used by the test. In order to replicate the same random number sequence for successive tests, one should use the same seed value. If this property is NULL, the diagnostic randomly selects its own seed using a vendor-specific algorithm.

7.3.4 CIM_DiskDriveDiagnosticSettingData.DataSizes

This array property is used by a client for the tests shown in Table 5 to specify the data buffer sizes to be used for read or write operations by the diagnostic test. If this property is NULL, the default size of 512 bytes is used.

The vendor-defined default value(s) is optionally advertised by the provider using the default instance of CIM_DiskDriveDiagnosticSettingData.

If both properties have values, they shall have the same number of values because the diagnostic test will treat them as value pairs. That is the test is run with the first value in DataSizes and the first value in DataPatterns, and so on. Test behavior is illustrated by the following examples:

1. DataSizes = {1024,1024}, DataPatterns = {5555555555555555,AAAAAAAAAAAAAAAA}
2. DataSizes = {1024,2048}, DataPatterns = {AAAAAAAAAAAAAAAA,5555555555555555}

For the first data pair, the diagnostic test will run twice, first using DataSizes=1024 and DataPattterns=5555555555555555 and then using DataSizes=1024 and DataPattterns=AAAAAAAAAAAAAAAA.

For the second data pair, the diagnostic test will run twice, first using DataSizes=1024 and DataPattterns=AAAAAAAAAAAAAAAA and then using DataSizes=2048 and DataPattterns=5555555555555555.

NOTE: If CIM_DiskDriveDiagnosticServiceCapabilities.DataSizes has values, a client can specify only one or more of those values.

7.3.5 CIM_DiskDriveDiagnosticSettingData.DataPatterns

This array property is used by a client for the tests shown in Table 5 to specify the data pattern(s) to be used for write operations by the diagnostic test. If this property is NULL, the vendor-specific data pattern(s) is used.

The vendor-defined default value(s) is advertised by the provider using the default instance of CIM_DiskDriveDiagnosticSettingData

A data pattern is a string interpreted as a 16-digit hex value. For example, a data pattern of all ones would be FFFFFFFFFFFFFFFF while alternating ones and zeros would be 5555555555555555 or AAAAAAAAAAAAAAAA. The pattern will be replicated as needed to fill the specified data size.

NOTE: If CIM_DiskDriveDiagnosticServiceCapabilities.DataPatterns has values, the user can specify only one or more of those values.

7.4 CIM_DiskDriveDiagnosticServiceCapabilities

The SupportedLoopControl property is inherited form CIM_DiagnosticServiceCapabilities. It lists the loop controls that are supported by the Diagnostic Service. The values are: 0 (Unknown), 1 (Other), 2 (Continuous), 3 (Count), 4 (Timer), 5 (ErrorCount), 0x8000 (No Loop Control). For all disk drive diagnostic tests, SupportedLoopControl has a value of 0x8000 (No Loop Control) except for the Extended Self-Test which has the value of 4 (Timer).

395 **Table 6 - CIM_DiskDriveDiagnosticServiceCapabilities property requirements**

Test Name	ElementName*	Region	Seed	DataSizes	DataPatterns
Short Self-Test	Disk Drive Short Self				
Extended Self-Test	Disk Drive Extended Self				
Selective Self-Test	Disk Drive Region Self	Used			
Sequential Read	Disk Drive Sequential Read	Used		Used	
Random Read	Disk Drive Random Read	Used	Used	Used	
Sequential Read-Write-Read Compare	Disk Drive Sequential Read-Write-Read Compare	Used		Used	Used
Random Read-Write-Read Compare	Disk Drive Random Read-Write-Read Compare	Used	Used	Used	Used
Sequential Internal Verify	Disk Drive Sequential Internal Verify	Used			
Status	Disk Drive Status				
Grown Defect	Disk Drive Grown Defect				
4K Alignment	Disk Drive 4K Alignment				
Power Management	Disk Drive Power Management				
Performance	Disk Drive Performance			Used	

396 An asterisk (*) indicates that the property is inherited from the parent class CIM_DiagnosticServiceCapabilities

397 ### 7.4.1 CIM_DiskDriveDiagnosticServiceCapabilities.Region

398 This property is used by a provider to define whether or not the client can specify start and end disk
399 sectors for the region tests defined in Table 6.

400 If this property is TRUE, the client can use the values of CIM_DiskDriveDiagnosticSettingData.LBAStart
401 and CIM_DiskDriveDiagnosticSettingData.LBAEnd to control which disk sectors are tested.

402 ### 7.4.2 CIM_DiskDriveDiagnosticServiceCapabilities.Seed

403 This property is used by a provider to define whether or not the client can specify the seed for the tests
404 defined in Table 6 that generate a random number sequence for testing.

405 If this property is TRUE, the client can use the value of CIM_DiskDriveDiagnosticSettingData.Seed to
406 initiate the random number sequence generation.

407 ### 7.4.3 CIM_DiskDriveDiagnosticServiceCapabilities.DataSizes

408 This array property is used by a provider for the tests shown in Table 6 to specify the list of data sizes
409 supported by the test.

410 ### 7.4.4 CIM_DiskDriveDiagnosticServiceCapabilities.DataPatterns

411 This array property is used by a provider for the tests shown in Table 6 to specify the list of data patterns
412 supported by the test.

413 A data pattern is a string interpreted as a 16-digit hex value. For example, a data pattern of all ones would
414 be FFFFFFFFFFFFFFFF while alternating ones and zeros would be 5555555555555555 or
415 AAAAAAAAAAAAAAAA. The pattern will be repeated as necessary to fill the specified data size.

416 # 8 Methods

417 This clause details the requirements for supporting intrinsic operations and extrinsic methods for the CIM
418 elements defined by this profile.

419 ## 8.1 CIM_DiagnosticTest.RunDiagnosticService( )

420 The RunDiagnosticService( ) method shall return one of the return code values defined in “Table 2 –
421 RunDiagnosticsService( ) Method: Return Code Values” of DSP1002.

422 When failures occur during the execution of a diagnostic test, the failure shall be recorded in the instance
423 of CIM_DiagnosticServiceRecord associated with the test. The reason for the failure shall be recorded in
424 CIM_DiagnosticServiceRecord.ErrorCode[ ] and the corresponding
425 CIM_DiagnosticServiceRecord.ErrorCount[ ] shall be incremented. Other occurrences of the same failure
426 during the same test shall not create additional entries in CIM_DiagnosticServiceRecord.ErrorCode[ ], but
427 they shall cause the corresponding CIM_DiagnosticServiceRecord.ErrorCount[ ] to be incremented.
428 Profile Conventions for Operations.

429 Support for operations for each profile class (including associations) shall be as mandated in DSP1002
430 clauses 8.5 through 8.29.

431 ### 8.1.1 CIM_DiskDriveDiagnosticTest

432 All operations are supported as for CIM_DiagnosticTest in DSP1002.

433 ### 8.1.2 CIM_DiskDriveDiagnosticSettingData

434 All operations are supported as for CIM_DiagnosticSettingData in DSP1002.

435 ### 8.1.3 CIM_DiskDriveDiagnosticServiceCapabilities

436 All operations are supported as for CIM_DiagnosticServiceCapabilities in DSP1002.

437 ## 8.2 Profile conventions for operations

438 Support for operations for each profile class (including associations) shall be as mandated in DSP1002
439 clauses 8.5 through 8.29.

440 # 9 Use cases

441 This clause contains use cases for the *Disk Drive Diagnostics Profile.*

442 How to discover, configure and run the individual diagnostic tests is detailed in DSP1002. This clause
443 focuses on how to use the Disk Drive diagnostic tests to diagnose common SAN issues.

9.1 Use case summary

Table 7 summarizes the use cases that are described in this clause. The use cases are categorized and named, and references are provided to the body of the test that describes the use case.

NOTE: Although use case names follow the convention for naming classes, properties and methods in the schema, this naming was done for readability only and does not imply any functionality attached to the name.

The CIM_ prefix has been omitted from the class names in the use cases for readability.

Table 7 – Disk Drive Diagnostics Profile use cases

Category	Tests	Description
Core device verification		Provides quick device verification with minimal to no user interaction required. See 9.2.
Full functional verification		Verifies complete functionality in a running environment. May require some user interaction, but should also provide default values to adequately diagnose the device under test. See 9.3.
Full functional verification (preboot)		A more complete functional verification allowed by the pre-boot environment. See 9.4.
Stress test		Stresses the device for a user-defined amount of time or iterations in an attempt to expose failures during heavy use. See 9.5.

Before performing the use cases in this profile, it is assumed that a client has already utilized the use case methodology defined in DSP1002 to discover the following instances

- ManagedSystemElement (that is, disk drive instance(s) to be tested
- DiskDriveDiagnosticTest instance(s) to be used by this profile
- DiskDriveDiagnosticSettingData instance(s) to be used by this profile that will be passed to the DiskDriveDiagnosticTest.RunDiagnosticService( ) extrinsic method

9.2 Core device verification

To quickly verify that the disk is operating at a minimal functional level on a running system, a client performs the following steps:

1. Select the ManagedSystemElement instance to be tested.
2. Initialize the property values of DiagnosticSettingData as desired (for example, HaltOnError, LogOptions, etc.).
3. Initialize the DiskDriveDiagnosticTest instance to select the test to run (for example, DiskDriveTestType = 1 (Stress).
4. Invoke the DiskDriveDiagnosticTest.RunDiagnosticService( ) extrinsic method using the instances from steps 1 and 2 as arguments.
5. Repeat steps 2, 3 and 4 for running other tests.

9.3 Full functional verification

The use cases in this clause describe how the client can use the diagnostic tests to verify the health of Disk Drives and to locate them. The CIM_ prefix has been omitted from the class names in the use cases for readability.

To more completely verify the proper operation of a disk on a running system, a client performs the following steps:

1. Select the ManagedSystemElement instance to be tested.
2. Initialize the property values of DiagnosticSettingData as desired (for example, HaltOnError, LogOptions, etc.).
3. Initialize the DiskDriveDiagnosticTest instance to select the test to run (for example, DiskDriveTestType = 1 (Stress).
4. Invoke the DiskDriveDiagnosticTest.RunDiagnosticService( ) extrinsic method using the instances from steps 1 and 2 as arguments.
5. Repeat steps 2, 3 and 4 for running other tests.

9.4 Full functional verification (preboot)

To more completely verify the proper operation of a disk, a client performs the following steps before the system is booted:

1. Select the ManagedSystemElement instance to be tested.
2. Initialize the property values of DiagnosticSettingData as desired (for example, HaltOnError, LogOptions, etc.).
3. Select the DiskDriveDiagnosticTest instance that tests the Instruction set, (for example, DiskDriveTestType = 1 (Stress).
4. Invoke the DiskDriveDiagnosticTest.RunDiagnosticService( ) extrinsic method using the instances from steps 1 and 2 as arguments.
5. Repeat steps 2, 3 and 4 for running other tests.

9.5 Stress test

To more completely verify the proper operation of a disk, a client performs the following steps before the system is booted:

1. Select the ManagedSystemElement instance to be tested.
2. Initialize the property values of DiagnosticSettingData as desired (for example, HaltOnError, LogOptions, etc.).
3. Select the DiskDriveDiagnosticTest instance that tests the Instruction set, for example DiskDriveTestType = 1 (Stress).
4. Invoke the DiskDriveDiagnosticTest.RunDiagnosticService( ) extrinsic method using the instances from steps 1 and 2 as arguments.
5. Repeat steps 2, 3 and 4 for running other tests.

10 CIM elements

Table 8 shows the instances of CIM elements for this profile. Instances of the CIM elements shall be implemented as described in Table 8. Clause 7 ("Implementation") and Clause 8 ("Methods") may impose additional requirements on these elements.

Table 8 – CIM elements: Disk Drive Diagnostics Profile

Element name	Requirement	Description
Classes		
CIM_DiskDriveDiagnosticTest	Mandatory	See 10.1.
CIM_DiskDriveDiagnosticSettingData	Optional	See 10.2.
CIM_DiskDriveDiagnosticServiceCapabilities	Optional	See 10.3.
CIM_RegisteredProfile	Mandatory	See 10.4.
CIM_AffectedJobElement	Optional	See 10.5.
CIM_AvailableDiagnosticService	Mandatory	See 10.6.
CIM_ElementCapabilities	Optional	See 10.7.
CIM_ElementSettingData (DiagnosticSettingData)	Optional	See 10.8.
CIM_ElementSettingData (JobSettingData)	Optional	See 10.9.
CIM_ElementSoftwareIdentity	Mandatory	See 10.10.
CIM_HostedService	Mandatory	See 10.11.
CIM_OwningJobElement	Mandatory	See 10.12.
CIM_RecordAppliesToElement	Optional	See 10.13.
CIM_ServiceAffectsElement	Mandatory	See 10.14.
CIM_ServiceAvailableToElement	Optional	See 10.15.
CIM_ServiceComponent	Optional	See 10.16.
CIM_UseOfLog	Mandatory	See 10.17.
Indications		
None defined in this profile		

10.1 CIM_DiskDriveDiagnosticTest (specializes CIM_DIagnosticTest)

CIM_DiskDriveDiagnosticTest is used to represent the Diagnostic Testing for a Disk Drive. This class specializes CIM_DiagnosticTest as defined in the *Diagnostics Profile*. The constraints listed in Table 9 are in addition to those specified in the *Diagnostics Profile*. See the *Diagnostics Profile* for other mandatory elements that must be implemented.

Table 9 – Class: CIM_DiskDriveDiagnosticTest

Elements	Requirement	Notes
ElementName	Mandatory	See 7.2.
Characteristics	Mandatory	See 7.2.

Elements	Requirement	Notes
OtherCharacteristicsDescriptions	Conditional	If Characteristics includes the value of 1 (Other), this property is Mandatory.
DiskDriveTestType	Mandatory	See 7.2.
OtherDiskDriveTestTypeDescription	Conditional	If DiskDriveTestType has a value of 1 (Other), this property is Mandatory.

10.2 CIM_DiskDriveDiagnosticSettingData (specializes CIM_DiagnosticSettingData)

CIM_DiskDriveDiagnosticSettingData is used to pass in test parameters and to specify other test control parameters. This class specializes CIM_DiagnosticSettingData as defined in the *Diagnostics Profile*. The constraints listed in Table 10 are in addition to those specified in the *Diagnostics Profile*. See the *Diagnostics Profile* for other mandatory elements that must be implemented.

Table 10 – Class: CIM_DiskDriveDiagnosticSettingData

Elements	Requirement	Notes
ElementName	Mandatory	See 7.3.
LBAStart	Optional	See 7.3.1.
LBAEnd	Optional	See 7.3.2.
Seed	Optional	See 7.3.3.
DataSizes	Optional	See 7.3.4.
DataPatterns	Optional	See 7.3.5.

10.3 CIM_DiskDriveDiagnosticServiceCapabilities (specializes CIM_DiagnosticServiceCapabilities)

CIM_DiskDriveDiagnosticServiceCapabilities is used to provide information on the capabilities for the Disk Drive Diagnostic Service. This class specializes CIM_DiagnosticServiceCapabilities as defined in the *Diagnostics Profile*. The constraints listed in Table 11 are in addition to those specified in the *Diagnostics Profile*. See the *Diagnostics Profile* for other mandatory elements that must be implemented.

Table 11 – Class: CIM_DiskDriveDiagnosticServiceCapabilities

Elements	Requirement	Notes
ElementName	Mandatory	See 7.4.
Region	Optional	See 7.4.1.
Seed	Optional	See 7.4.2.
DataSizes	Optional	See 7.4.3.
DataPatterns	Optional	See 7.4.4.

10.4 CIM_RegisteredProfile

The CIM_RegisteredProfile class is defined by the *Profile Registration Profile*. The requirements denoted in Table 12 are in addition to those mandated by the *Profile Registration Profile*. See the *Profile Registration Profile* for the other mandatory elements that must be implemented.

533 **Table 12 – Class: CIM_RegisteredProfile**

Elements	Requirement	Notes
RegisteredName	Mandatory	This property shall be “Disk Drive Diagnostics”.
RegisteredVersion	Mandatory	This property shall be “1.0.0”.
RegisteredOrganization	Mandatory	This property shall be 2 (DMTF).

534 ## 10.5 CIM_AffectedJobElement

535 Although defined in the *Diagnostics Profile*, the CIM_AffectedJobElement class is listed here because the
536 AffectedElement reference is scoped down to a subclass of CIM_ManagedElement as specified in clause
537 5. The constraints listed in Table 13 are in addition to those specified in the *Diagnostics Profile*. See the
538 *Diagnostics Profile* for other mandatory properties of CIM_AffectedJobElement that must be
539 implemented.

540 **Table 13 – Class: CIM_AffectedJobElement**

Properties	Requirement	Notes
AffectedElement (overridden)	Mandatory	This property shall be a reference to an instance of the CIM_ManagedElement subclass specified in clause 5.
AffectingElement	Mandatory	This property shall be a reference to an instance of CIM_ConcreteJob.

541 ## 10.6 CIM_AvailableDiagnosticService

542 Although defined in the *Diagnostics Profile*, the CIM_AvailableDiagnosticService class is listed here
543 because the ServiceProvided reference is scoped down to CIM_DiskDriveDiagnosticTest, which is a
544 subclass of CIM_DiagnosticTest, and the UserOfService reference is scoped down to a subclass of
545 CIM_ManagedElement as specified in clause 5. The constraints listed in Table 14 are in addition to those
546 specified in the *Diagnostics Profile*. See the *Diagnostics Profile* for other mandatory properties of
547 CIM_AvailableDiagnosticService that must be implemented.

548 **Table 14 – Class: CIM_AvailableDiagnosticService**

Properties	Requirement	Notes
ServiceProvided (overridden)	Mandatory	This property shall be a reference to an instance of CIM_DiskDriveDiagnosticTest.
UserOfService (overridden)	Mandatory	This property shall be a reference to an instance of the CIM_ManagedElement subclass specified in clause 5.

549 ## 10.7 CIM_ElementCapabilties

550 Although defined in the *Diagnostics Profile*, the CIM_ElementCapabilities class is listed here because the
551 ManagedElement reference is scoped down to CIM_DiskDriveDiagnosticTest, which is a subclass of
552 CIM_DiagnosticTest, and the Capabilities reference is scoped down to
553 CIM_DiskDriveDiagnosticServiceCapabilities, which is a subclass of CIM_DiagnosticServiceCapabilities.
554 The constraints listed in Table 15 are in addition to those specified in the *Diagnostics Profile*. See the
555 *Diagnostics Profile* for other mandatory properties of CIM_ElementCapabilities that must be implemented.

556 **Table 15 – Class: CIM_ElementCapabilities**

Properties	Requirement	Notes
ManagedElement (overridden)	Mandatory	This property shall be a reference to an instance of CIM_DiskDriveDiagnosticTest.
Capabilities (overridden)	Mandatory	This property shall be a reference to an instance of CIM_DiskDriveDiagnosticServiceCapabilities.

557 ## 10.8 CIM_ElementSettingData (DiagnosticSettingData)

558 Although defined in the *Diagnostics Profile*, the CIM_ElementSettingData class is listed here because the
559 ManagedElement reference is scoped down to CIM_DiskDriveDiagnosticTest, which is a subclass of
560 CIM_DiagnosticTest, and the SettingData reference is scoped down to
561 CIM_DiskDriveDiagnosticSettingData, which is a subclass of CIM_DiagnosticSettingData. The constraints
562 listed in Table 16 are in addition to those specified in the *Diagnostics Profile*. See the *Diagnostics Profile*
563 for other mandatory properties of CIM_ElementSettingData that must be implemented.

564 **Table 16 – Class: CIM_ElementSettingData**

Properties	Requirement	Notes
ManagedElement (overridden)	Mandatory	This property shall be a reference to an instance of CIM_DiskDriveDiagnosticTest.
SettingData (overridden)	Mandatory	This property shall be a reference to an instance of CIM_DiskDriveDiagnosticSettingData.
IsDefault	Mandatory	If the instance of CIM_DiskDriveDiagnosticSettingData is the default setting, this property shall have the value of TRUE.

565 ## 10.9 CIM_ElementSettingData (JobSettingData)

566 Although defined in the *Diagnostics Profile*, the CIM_ElementSettingData class is listed here because the
567 Dependent reference is scoped down to CIM_DiskDriveDiagnosticTest, which is a subclass of
568 CIM_DiagnosticTest, and the SettingData reference is scoped down to CIM_JobSettingData, which is a
569 subclass of CIM_SettingData. The constraints listed in Table 17 are in addition to those specified in the
570 *Diagnostics Profile*. See the *Diagnostics Profile* for other mandatory properties of
571 CIM_ElementSettingData that must be implemented.

572 **Table 17 – Class: CIM_ElementSettingData**

Properties	Requirement	Notes
ManagedElement (overridden)	Mandatory	This property shall be a reference to an instance of CIM_DiskDriveDiagnosticTest.
SettingData (overridden)	Mandatory	This property shall be a reference to an instance of CIM_JobSettingData.
IsDefault	Mandatory	If the instance of CIM_JobSettingData is the default setting, this property shall have the value of TRUE.

10.10 CIM_ElementSoftwareIdentity

Although defined in the *Diagnostics Profile*, the CIM_ElementSoftwareIdentity class is listed here because the Dependent reference is scoped down to CIM_DiskDriveDiagnosticTest, which is a subclass of CIM_DiagnosticTest. The constraints listed in Table 18 are in addition to those specified in the *Diagnostics Profile*. See the *Diagnostics Profile* for other mandatory properties of CIM_ElementSoftwareIdentity that must be implemented.

Table 18 – Class: CIM_ElementSoftwareIdentity

Properties	Requirement	Notes
Antecedent	Mandatory	This property shall be a reference to an instance of CIM_SoftwareIdentity.
Dependent (overridden)	Mandatory	This property shall be a reference to an instance of CIM_DiskDriveDiagnosticTest.

10.11 CIM_HostedService

Although defined in the *Diagnostics Profile*, the CIM_HostedService class is listed here because the Dependent reference is scoped down to CIM_DiskDriveDiagnosticTest, which is a subclass of CIM_DiagnosticTest. The constraints listed in Table 19 are in addition to those specified in the *Diagnostics Profile*. See the *Diagnostics Profile* for other mandatory properties of CIM_HostedService that must be implemented.

Table 19 – Class: CIM_HostedService

Properties	Requirement	Notes
Antecedent	Mandatory	This property shall be a reference to an instance of CIM_ComputerSystem.
Dependent (overridden)	Mandatory	This property shall be a reference to an instance of CIM_DiskDriveDiagnosticTest.

10.12 CIM_OwningJobElement

Although defined in the *Diagnostics Profile*, the CIM_OwningJobElement class is listed here because the OwningElement reference is scoped down to CIM_DiskDriveDiagnosticTest, which is a subclass of CIM_DiagnosticTest. The constraints listed in Table 20 are in addition to those specified in the *Diagnostics Profile*. See the *Diagnostics Profile* for other mandatory properties of CIM_OwningJobElement that must be implemented.

Table 20 – Class: CIM_OwningJobElement

Properties	Requirement	Notes
OwningElement (overridden)	Mandatory	This property shall be a reference to an instance of CIM_DiskDriveDiagnosticTest.
OwnedElement	Mandatory	This property shall be a reference to an instance of CIM_ConcreteJob.

10.13 CIM_RecordAppliesToElement

Although defined in the *Diagnostics Profile*, the CIM_RecordAppliesToElement class is listed here because the Dependent reference is scoped down to CIM_DiskDriveDiagnosticTest, which is a subclass

of CIM_DiagnosticTest. The constraints listed in Table 21 are in addition to those specified in the *Diagnostics Profile*. See the *Diagnostics Profile* for other mandatory properties of CIM_RecordAppliesToElement that must be implemented.

Table 21 – Class: CIM_RecordAppliesToElement

Properties	Requirement	Notes
Antecedent	Mandatory	This property shall be a reference to an instance of CIM_RecordForLog.
Dependent (overridden)	Mandatory	This property shall be a reference to an instance of CIM_DiskDriveDiagnosticTest.

10.14 CIM_ServiceAffectsElement

Although defined in the *Diagnostics Profile*, the CIM_ServiceAffectsElement class is listed here because the AffectedElement reference is scoped down to a subclass of CIM_ManagedElement as specified in clause 5, and the AffectingElement reference is scoped down to CIM_DiskDriveDiagnosticTest, which is a subclass of CIM_DiagnosticTest. The constraints listed in Table 22 are in addition to those specified in the *Diagnostics Profile*. See the *Diagnostics Profile* for other mandatory properties of CIM_ServiceAffectsElement that must be implemented.

Table 22 – Class: CIM_ServiceAffectsElement

Properties	Requirement	Notes
AffectedElement (overridden)	Mandatory	This property shall be a reference to an instance of the CIM_ManagedElement subclass specified in clause 5.
AffectingElement (overridden)	Mandatory	This property shall be a reference to an instance of CIM_DiskDriveDiagnosticTest.

10.15 CIM_ServiceAvailableToElement

Although defined in the *Diagnostics Profile*, the CIM_ServiceAvailableToElement class is listed here because the UsersOfService reference is scoped down to CIM_DiskDriveDiagnosticTest, which is a subclass of CIM_DiagnosticTest. The constraints listed in Table 23 are in addition to those specified in the *Diagnostics Profile*. See the *Diagnostics Profile* for other mandatory properties of CIM_ServiceAvailableToElement that must be implemented.

Table 23 – Class: CIM_ServiceAvailableToElement

Properties	Requirement	Notes
ServiceProvided	Mandatory	This property shall be a reference to an instance of CIM_HelpService.
UsersOfService (overridden)	Mandatory	This property shall be a reference to an instance of CIM_DiskDriveDiagnosticTest.

10.16 CIM_ServiceComponent

Although defined in the *Diagnostics Profile*, the CIM_ServiceComponent class is listed here because the GroupComponent reference is scoped down to CIM_DiskDriveDiagnosticTest, which is a subclass of CIM_DiagnosticTest, and the PartComponent reference is scoped down to CIM_DiskDriveDiagnosticTest, which is a subclass of CIM_DiagnosticTest. The constraints listed in Table 24 are in addition to those

specified in the *Diagnostics Profile*. See the *Diagnostics Profile* for other mandatory properties of CIM_ServiceComponent that must be implemented.

Table 24 – Class: CIM_ServiceComponent

Properties	Requirement	Notes
GroupComponent (overridden)	Mandatory	This property shall be a reference to an instance of CIM_DiskDriveDiagnosticTest.
PartComponent (overridden)	Mandatory	This property shall be a reference to an instance of CIM_DiskDriveDiagnosticTest.

10.17 CIM_UseOfLog

Although defined in the *Diagnostics Profile*, the CIM_UseOfLog class is listed here because the Dependent reference is scoped down to CIM_DiskDriveDiagnosticTest, which is a subclass of CIM_DiagnosticTest. The constraints listed in Table 25 are in addition to those specified in the *Diagnostics Profile*. See the *Diagnostics Profile* for other mandatory properties of CIM_UseOfLog that must be implemented.

Table 25 – Class: CIM_UseOfLog

Properties	Requirement	Notes
Antecedent	Mandatory	This property shall be a reference to an instance of CIM_DiagnosticLog.
Dependent (overridden)	Mandatory	This property shall be a reference to an instance of CIM_DiskDriveDiagnosticTest.

ANNEX A (informative)

S.M.A.R.T. Tests

S.M.A.R.T. includes disk diagnostic tests and attributes that can be used to monitor disk drive status, collect statistics, test components or subsystems and predict upcoming failures. S.M.A.R.T. support is available for many platforms (Linux, Windows, etc.). Many motherboard and disk drive vendors provide S.M.A.R.T. utilities customized for the tests and attributes supported by their product.

S.M.A.R.T. defines a list of attributes identified by an ID number. The list of attributes can be categorized into several functional groups. Some are counters for particular error conditions. Others are simply usage counters that are not necessarily indicative of aberrant behavior.

A disk drive vendor may support one or more attributes. The disk will update the raw value of each supported attribute. Each disk drive vendor defines their own alert threshold for each supported attribute.

Since implementations may use S.M.A.R.T. technology to perform some of the diagnostic tests, information regarding S.M.A.R.T. is provided for convenience.

A.1 Self Test

S.M.A.R.T. defines a generic Self test that verifies that the disk is operating properly. The specific tests performed by a Self test are dependent upon the vendor and individual product features. Typically, a user may specify a short Self test that runs several minutes or an extended Self test that may run much longer. Self tests may be run online or offline.

A.2 Cache Test

A Cache diagnostic verifies that the cache subsystem is operating properly. Typically, disks have separate read-ahead cache and write cache. A user may choose to test either or both. S.M.A.R.T. defines a cache related attribute called End-to-End Error (ID = 184). This error counter is incremented whenever the disk detects that parity has changed after data has been transferred between the host and disk through a cache.

A.3 Seek Tests

A Seek diagnostic verifies that all read and write heads of a disk can seek to all cylinders on their platter. A user may choose to have the heads seek to cylinders in a sequential or random manner. A user may also select a subset of disk sectors by specifying a starting and ending LBA.

S.M.A.R.T. defines an attribute, called Seek Error Rate (ID = 7), that monitors the frequency of head positioning errors. A rising rate may indicate upcoming disk failure.

A.4 Sector Remap Tests

Over time, a percentage of physical disk sectors become unusable. A disk reserves a number of spare sectors that can be used to dynamically replace permanently damaged sectors. When a disk detects a permanent sector failure, it automatically remaps the logical sector from the failed physical sector to a spare physical sector.

Additionally, some disk sectors cannot be used to store user data because they are reserved for use by the operating system or other purpose.

S.M.A.R.T. defines several attributes related to bad block mapping. They are as follows:

- Reallocated Sector Count (ID = 5) – The count of reallocated sectors.
- Reallocation Event Count (ID = 196) – The count of sector remap operations
- Current Pending Sector Count (ID = 197) – The number of "unstable" sectors (waiting to be remapped because of read errors).
- Uncorrectable Sector Count (ID = 198) – The number of unusable sectors.

A.5 Read Tests

A read diagnostic verifies that all read heads of a disk can read all disk sectors. A user may choose to read sectors in a sequential or random manner. A user may also select a subset of disk sectors by specifying a starting and ending LBA.

S.M.A.R.T. defines several attributes related to read operations. They are as follows:

- Raw Read Error Rate (ID = 1) – The frequency of errors occurred while reading raw data
- Soft Read Error Rate (ID = 13) – The number of uncorrected read errors reported to the OS
- TA Counter Detected (ID = 201) – The count of off-track errors
- Read Error Retry Rate (ID = 205) – The number of retries of read operations

A.6 Write Tests

A write diagnostic verifies that all write heads of a disk can write to all disk sectors. A user may choose to write to sectors in a sequential or random manner. A user may also select a subset of disk sectors by specifying a starting and ending LBA.

S.M.A.R.T. defines the following attribute related to write operations:

- Write Error Rate (ID = 200) – The number of write errors

A.7 Disk Information

Disks may support the capability to return device and product information, such as the following:

- Device Model
- Serial Number
- Firmware Version
- Capacity
- Interface type (for example, SCSI, SATA, PATA, etc.)

A Disk Information diagnostic verifies that such data can be retrieved and that the retrieved data is accurate.

A.8 Environmental Sensor Tests

A disk must operate properly within a specified range of environmental parameters. Disks may have sensors that monitor certain environmental conditions. An Environmental Sensor test verifies that these sensors are operating properly.

S.M.A.R.T. defines several attributes related to environmental sensors built into the disk. They are as follows:

- InducedOp-Vibration Detection (ID = 186)
- Airflow Temperature (ID = 190) – Current airflow temperature
- Disk Temperature (ID = 194) – Current disk temperature
- Thermal Asperity Count (ID = 205) – The number of errors caused by high temperature
- Vibration During Write (ID = 211)
- Shock During Write (ID = 212)
- G-Sense Error Rate (ID = 221) – The number of errors caused by external shock or vibration
- Free Fall Event Count (ID = 254) – The number of “free fall” (drops) suffered by the disk

Other environmental factors that may be tested are as follows:

- Altitude – that the disk properly operates at certain atmospheric pressures
- Electromagnetic Immunity – that the disk properly operates when subject to certain strengths of electromagnetic fields
- Humidity – that the disk properly operates at certain levels of relative humidity

A.9 Operation Sensor Tests

A disk consists of many moving components (for example heads, platters, etc) which must operate within a specified range of speed and motion. Most disks have sensors that monitor certain operating conditions to detect when potentially harmful situations occur. An Operation Sensor test verifies that these sensors are operating properly.

S.M.A.R.T. defines several attributes related to operation sensors built into the disk. They are as follows:

- Head stability (ID = 185)
- High Fly Writes (ID = 189) – The number of unsafe write operations outside the normal head flying range
- Flying Height (ID = 206) – Current head flying height
- Spin High Current (ID = 207) – Amount of current used to spin up the drive
- Load Friction (ID = 224) – Resistance caused by friction of mechanical parts of magnetic head armature
- Disk Shift (ID = 220) – Distance the disk has shifted relative to the spindle

A.10 Power Management Tests

Disks provide support for different power consumption modes such as:

- Active
- Active Idle
- Low Power Idle
- Standby
- Sleep/Hibernate

A Power Management diagnostic verifies that the disk can enter and return from each supported power consumption mode.

A.11 Malfunction Indicator Tests

Disks collect data and statistics that can be used to alert the user of rising error rates or levels that may indicate upcoming disk failure or degraded operation. The Malfunction Indicator test verifies that the disk can accurately collect these statistics and data and return them upon request.

S.M.A.R.T. defines several attributes related to malfunction indicators. They are as follows:

- Read Channel Margin (ID = 6) – The number of read operations that occur in the read channel margin
- Spin Retry Count (ID = 10) – The number of retries of spin start attempts
- Drive Recalibration Retry Count (ID = 11) – The number of attempts to recalibrate the drive
- Spin Buzz (ID = 208) – The number of buzz routines needed to spin up the drive due to insufficient power
- Torque Amplification Count (ID = 227) – The number of attempts to compensate for platter speed variations
- GMR Head Amplitude (ID = 230) – The amplitude of “thrashing” (distance of repetitive forward/reverse head motion)

A.12 Performance

Disks collect performance data on various aspects of their operation that can be used to alert the user of degrading performance that may indicate upcoming disk failure. The Performance test verifies that the disk can accurately collect performance data and return them upon request.

S.M.A.R.T. defines several attributes related to performance measurement. They are as follows:

- Throughput performance (ID = 2) – General throughput performance. Degrading performance may indicate upcoming motor, servo or bearing failure.
- Spin-Up Time (ID = 3) – Time needed by spindle to spin up to full RPMs. Degrading performance may indicate upcoming motor or bearing failure.
- Seek Time Performance (ID = 8) – Average time of seek operations. Degrading performance may indicate upcoming servo failure.
- Offline Seek Performance (ID = 209) – Drive performance as measured during a Self test

A.13 Usage Meters

Disks maintain counters that monitor the overall usage of the drive. These counters measure how often a particular operation or event has occurred but do not necessarily indicated any error condition. The Usage Meters test verifies that these counters are operating properly.

S.M.A.R.T. defines attributes related usage meters. They are as follows:

- Start/Stop Count (ID = 4) – The number of spindle start/stop cycles.
- Power-On Hours (ID = 9) – The amount of time the drive is powered on
- Power Cycle Count (ID = 12) – The number of power on/off cycles
- Power Off Retract Count (ID = 192) – The number of times when the heads are unloaded from the media for a power off operation

- Load Cycle Count (ID = 193) – The number of time the head are moved to a landing zone position
- Loaded Hours (ID = 222) – The amount of time the disk where the magnetic head armature is active
- Load/Unload Retry Count (ID = 223) – The number of times read/write heads enter/exit a data zone
- Load/Unload Cycle Count (ID = 225) – The number of load/unload cycles
- Load-In Time (ID = 226) – The amount of time read/write heads are in a data zone
- Power-Off Retract Cycle (ID = 228) – The number of times that the magnetic armature was retracted automatically because power was turned off
- Head Flying Hours (ID = 240) – The total amount of time spent to position a head
- Total LBAs Written (ID = 241)
- Total LBAs Read (ID = 242)

A.14 Error Counters

Disks maintain counters for a set of detected errors. The Error Counters test verifies that these counters are operating properly.

S.M.A.R.T. defines attributes related to monitor errors, some of which are included in other diagnostic tests. These remaining error attributes are as follows:

- SATA Downshift Error Count (ID = 183)
- Reported Uncorrectable Errors (ID = 187) – The number of errors that could not be corrected using hardware ECC
- Command Timeout (ID = 188) – The number of aborted operations caused by disk command timeout
- UltraDMA CRC Error Count (ID = 199) – The number of detected data transfer errors across the interface cable
- Data Address Mark Errors (ID = 202)
- Run Out Cancel (ID = 203) – The number of errors that were corrected using hardware ECC
- Soft ECC Correction (ID = 204) – The number of errors that were corrected using software ECC
- Transfer Error Rate (ID = 240) – The number of data transfer errors caused by a link reset

Table Table A-1 represents the list of tests that are used by one disk drive vendor.

Table A-1 – One vendor's disk drive tests

Test Name	Description
Device Information	This provides information about the HDD (model string, serial #, capacity, config verification, firmware revision)(can possibly get device info even though drive cannot perform I/O)(no user controls)
SMART Short Self-Test	This executes the SMART (Self-Monitoring, Analysis, and Reporting Technology) drive self-test routine. This test runs only on SATA and SCSI drives that support off-line data collection or self-test. (runs just a subset, returns success/failure status only, no user control, a few minutes) For SCSI, a Self-Test is initiated using a Send Diagnostic command (operation code = 1D) while the results of the Self-Test are retrieved using a Receive Diagnostics Results command (operation code = 1C)
SMART Status Test	This checks the status of predictive failures for SATA and SCSI hard disk drives that support SMART. (examines error/failure statistics collected by drive, no user control, immediate return)
SMART Extended Self-Test	This test runs the drive's SMART extended self-test for hard disk drives that support SMART technology (no user control, longer than short self-test, maybe an hour to run, full set of implemented tests)
SMART Selective (LBA) Self-Test	This test runs the drive's SMART extended self-test selectively - only for the specified Spans. There are 3 expected supported spans: Span1 is at the start of the drive, Span2 is in the middle of the drive and Span3 is at the end of the drive. This is for hard disk drives that support SMART technology (user selects the LBA range but not the tests to run)
SMART Timed Self-Test	This test runs the drive's SMART extended self-test only for the specified time. This is for hard disk drives that support SMART technology (runs through ordered list of tests and stops after a period of time at whatever test it is running)
Performance/Speed Test	Determines the data transfer rate, the sequential seek time, and the random seek time based on transfer size, seek count, and data transferred.
Sequential Read Test	This test checks the drive head's ability to read from sector to sector in a straight line, beginning from the first sector and continuing sequentially to the last sector. (user can specify LBA range, size of data transferred) (data is transferred to host)

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Test Name	Description
Sequential Read-Write-Read-Compare	This test checks the drive head's ability to sequentially read specified range of blocks (start, end, and skip blocks) and writes the read data back. The test then reads the data a second time and compares it with the data that was originally read. (user specified LBA range and size of data transferred, data is not actually changed intentionally, is Risky, bad sector remap is transparent to this test)
Sequential Verify Test	This test verifies the drive's ability to read and verify sequentially from track to track and head to head. (uses ATA command) (no SCSI equivalent?) (data is not transferred to the host, internal verify)
Random Read Test	This test verifies the drive's ability to read data randomly from block to block. (user control by LBA range and size of data transferred, maybe random seed?)
Random Read-Write-Read-Compare	This test checks the drive head's ability to randomly read a specified range of blocks (begin, end and skip blocks) and writes the read data back. The test then reads the data a second time and compares it with the data that was originally read. (user specified LBA range and size of data transferred and maybe random seed(?), data is not actually changed intentionally, is Risky, bad sector remap is transparent to this test)
Region Test	The test performs reads a block of data, saves the data into a buffer, if read call passes, writes a specific pattern to that block, if write call passes, it reads it back, compares the data. Then, restores the original data. (is Risky, is Destructive, user specified LBA range and size of data transferred)
Grown Defects Test (B)	This test will find the number of grown defects on the drive. For ATA use ATA command. For SCSI use SCSI command.

ANNEX B
(informative)

Change Log

Version	Date	Description
1.0.0	2011-09-16	DMTF Standard