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Smart Data Centre Resource Monitoring and Control

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Contents

Introduction

Operation of data centres requires management of storage, computation, communication, electrical energy and temperature to achieve the required quality of service and efficiency parameters. Often, however, the separate management of Information Technology (IT), electrical energy (or power) and cooling Resource islands yields a sub-optimal result.

This Standard provides Messages that facilitate integrated or "smart" monitoring and control of Resources in those islands. The Messages are exchanged between the Management Function and Resources. The Standard acknowledges that those Resources may be composed of other Resources (e.g. a rack may contain servers, ventilators, etc.). In addition, e.g. those servers may be viewed from their computing, energy consumption or dissipation aspects which this Standard models as Resource Components and groups into IT, power and fluid Domains, respectively.

This Ecma Standard has been adopted by the General Assembly of June 2013.

Smart Data Centre Resource Monitoring and Control

1 Scope

In the Smart Data Centre, Management Functions monitor and control Resources. Resources model IT and facility equipment, systems and components in a data centre. To monitor and control the Resources' Properties, Management Functions exchange command, response or event Messages with Resources, see Figure 1.
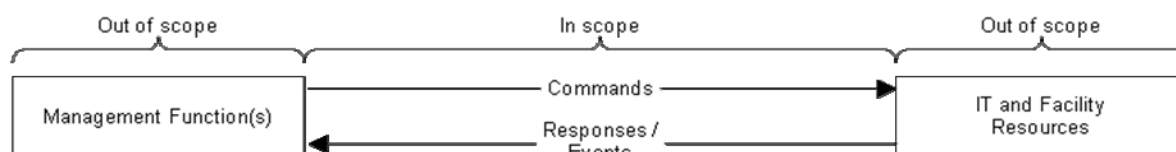
Figure 1 — Scope

Resources are made up out of Resource Components which this second edition shares Properties with classes in Common Information Models (CIM). Messages refer to Resources and their Properties. Messages are encoded in XML and exchanged in HTTP primitives.

Figure 1 illustrates the functionality that this second edition adds as described above.
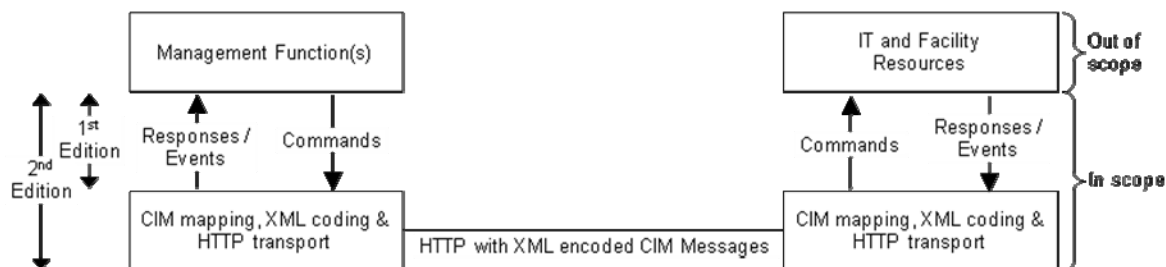
Figure 2 — Functionality that second edition adds

Management Function(s), Resources, IT & facility equipment, systems and components themselves are out of scope as illustrated in Figure 1, Figure 2 and Figure 3. Static information such as location, addressing of Resources and CPU models are out of scope as well.
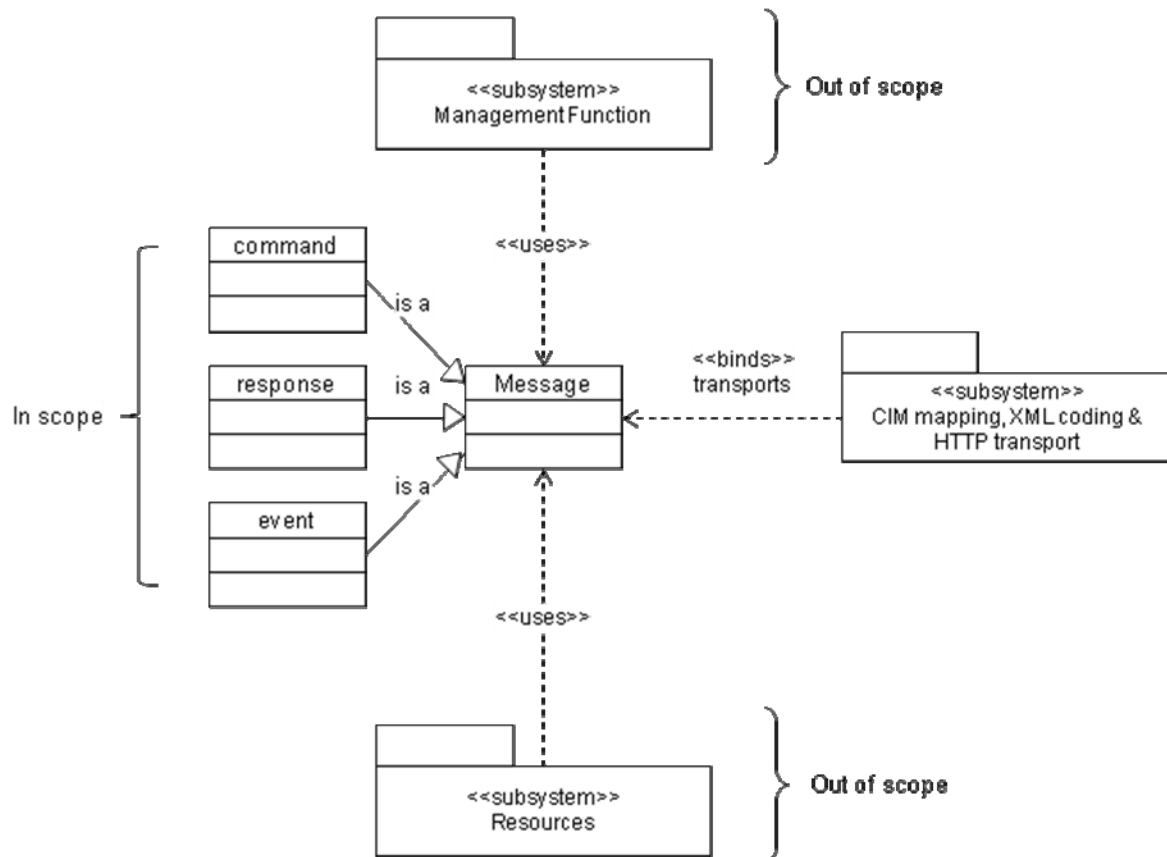
Figure 3 — detailed scope using CIM (UML Notation)

2 Conformance

Conformant Management Functions monitor and control Properties (Clause 6) of Resources using Messages as specified in Clause 7.

In response to the commands, conformant responses and events from Resources use the Messages as specified in Clause 7.

Any of the Resource configurations specified in Annex A may optionally be implemented, in addition to any other configuration using any combination of Resources and Resource Components.

3 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

DMTF, "CIM Schema", http://dmtf.org/standards/cim

DMTF DSP0004, "CIM Infrastructure Specification"

DMTF DSP0200, "CIM Operations over HTTP"

DMTF DSP1009, "Sensors Profile"

DMTF DSP1011, "Physical Asset Profile"

DMTF DSP1014, "Ethernet Port Profile"

DMTF DSP1022, "CPU Profile"

DMTF DSP1027, "Power State Management Profile"

DMTF DSP1029, "OS Status Profile"

DMTF DSP1033, "Profile Registration Profile"

DMTF DSP1035, "Host LAN Network Port Profile"

DMTF DSP1042, "System Virtualization Profile"

DMTF DSP1044, "Processor Resource Virtualization Profile"

DMTF DSP1045, "Memory Resource Virtualization Profile"

DMTF DSP1047, "Storage Resource Virtualization Profile"

DMTF DSP1052, "Computer System Profile"

DMTF DSP1053, "Base Metrics Profile"

DMTF DSP1057, "Virtual System Profile"

DMTF DSP1081, "Virtual System Migration Profile"

4 Terms, definitions and acronyms

For the purposes of this document, the following terms, definitions and acronyms apply.

4.1
Common Information Model
CIM

4.2
CIM Client
emitter of CIM message requests and consumer of CIM message responses

4.3
CIM Listener
consumer of events

4.4
CIM message request
command or event request

4.5
CIM message response
response

4.6
condition query
expression on property value

4.7
Distributed Management Task Force
DMTF

NOTE   DMTF's URL is http://www.dmtf.org/

4.8
domain
set of resource components

4.9
event description indication filter
set of conditions and associated parameters

4.10
Information Technology
IT

4.11
CIM message
command, response or event

4.12
Management Function
MF

4.13
property
resource attribute

4.14
Resource Component
RC

4.15
CIM Resource
representation of IT and facility equipment, systems or components

4.16
Smart Data Centre
SDC
arrangement of all the resources and management function(s)

5   Domains

5.1   Introduction

This Standard specifies Resource Components (RC) which share Properties with CIM classes, to compose Resource configurations as specified in Figure 3. The Resource Components are grouped into IT, power, fluid and base Domains.
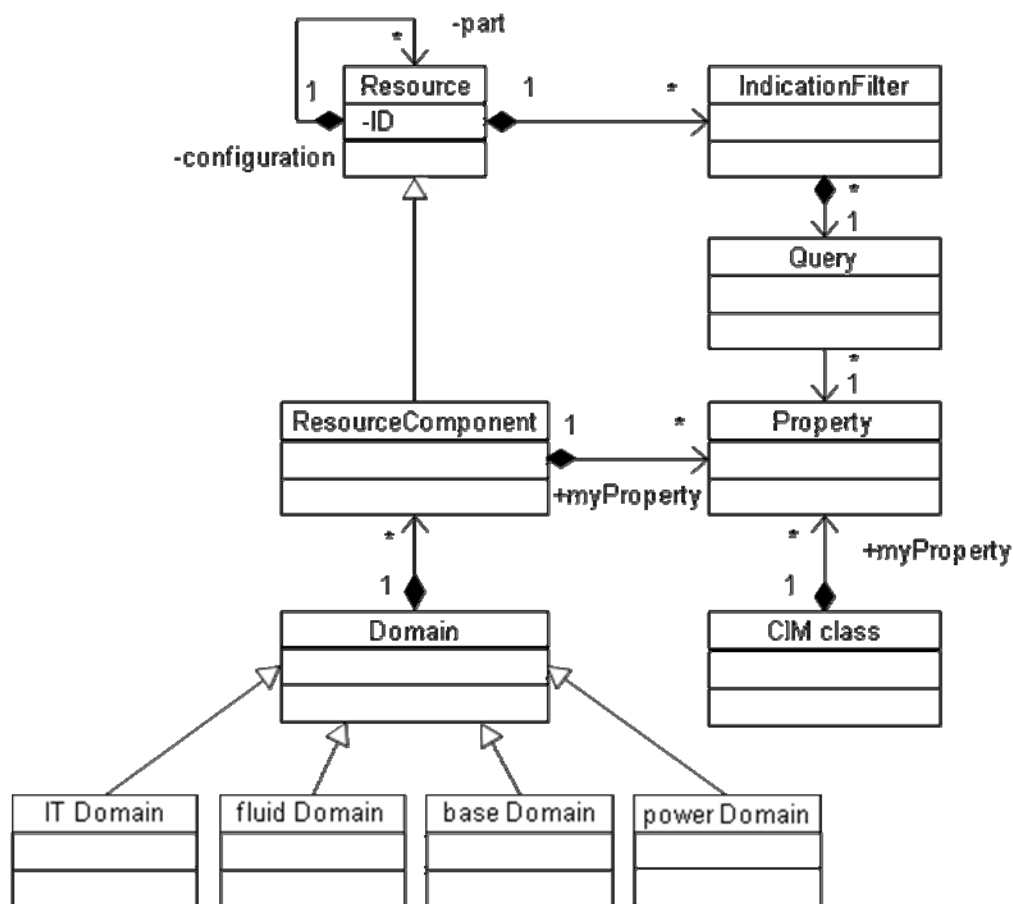
Figure 4 — Resource and Resource Component

In tables in this Clause, the Key indicates the identifier which shall be unique in the SDC namespace as specified in *Common Information Model (CIM) Infrastructure Specification* (DSP0004). The Key uniquely identifies each instance.

5.2 Base Domain

To construct the foundation of Resources, Resource Components from the base Domain shall be used.

5.2.1 CIM_System

See *CIM Schema*.

5.2.2 CIM_BaseMetricDefinition

See *Base Metrics Profile* (DSP1053). TimeScope is optional in DSP1053 whereas in this Standard, TimeScope is mandatory.

5.2.3 CIM_BaseMetricValue

The requirements in *Base Metrics Profile* (DSP1053) and those in Table 1 apply.

Table 1 — Class: CIM_BaseMetricValue

Properties	M/O[1]	Requirements on Value
TimeStamp	Mandatory	In case the device generating the metric instances does not have a clock device, the TimeStamp value shall be "99990101000000.000000+000" in case the base metric definition time scope requires that the TimeStamp value is not NULL. "99990101000000.000000+000" is used to indicate that the DateTime property value is not valid.
Volatile	Mandatory	TRUE

[1] "M/O" indicates "mandatory or optional."

5.2.4 CIM_MetricDefForME

CIM_MetricDefForME shall be used to associate CIM_BaseMetricDefinition to SDC_FluidMeasurementPoint. The requirements in *Base Metrics Profile* (DSP1053) and those in Table 2 apply.

If the CIM_BaseMetricDefinition class is implemented, CIM_MetricDefForME shall be also implemented.

Table 2 — Class: CIM_MetricDefForME

Properties	M/O	Requirements on value
Antecedent	Mandatory	**Key**: Shall be a reference to SDC_FluidMeasurementPoint with Cardinality 1 indicating one reference
Dependent	Mandatory	**Key**: Shall be a reference to CIM_BaseMetricDefinition with Cardinality 1..* indicating one or more references
MetricCollectionEnabled	Optional	

5.2.5 CIM_MetricInstance

CIM_MetricInstance shall be used to associate CIM_BaseMetricValue instances to CIM_BaseMetricValue instances. See *Base Metrics Profile* (DSP1053).

If the CIM_BaseMetricDefinition class is implemented, CIM_MetricInstance shall be also implemented.

5.2.6 CIM_RegisteredProfile

The requirements in *Profile Registration Profile* (DSP1033) and those in Table 3 apply.

Table 3 — Class: CIM_RegisteredProfile

Properties	M/O	Requirements on value
RegisteredName	Mandatory	"CoolingSystem"
RegisteredVersion	Mandatory	"1.0.0"
RegisteredOrganization	Mandatory	1 (Others)
OtherRegisteredOrganization	Mandatory	"Ecma_TGG"

5.2.7 CIM_SystemDevice

CIM_SystemDevice association shall be used to associate SDC_FluidElement with the CIM_System instance of which it is a member. The requirements in *CIM Schema* and those in Table 4 apply.

Table 4 — Class: CIM_SystemDevice

Properties	M/O	Requirements on value
Antecedent	Mandatory	**Key**: Shall be a reference to CIM_System with Cardinality 1 indicating one reference
Dependent	Mandatory	**Key**: Shall be a reference to SDC_FluidElement with Cardinality 1..* indicating one or more references

5.2.8 CIM_Component

CIM_Component association shall be used to associate SDC_FluidElement instances of which it is involved. The requirements in *CIM Schema* and those in Table 5 apply.

Table 5 — Class: CIM_Component

Properties	M/O	Requirements on value
Antecedent	Mandatory	**Key**: Shall be a reference to SDC_FluidElement with Cardinality 1 indicating one reference
Dependent	Mandatory	**Key**: Shall be a reference to SDC_FluidElement with Cardinality 1..* indicating one or more references

5.2.9 Metrics for fluid measurements

The set of fluid metrics supported by an instance of SDC_FluidMeasurementPoint is implementation dependent. An instance of SDC_FluidMeasurementPoint may support all, none, or any combination of these metrics. A Management Function may detect the supported metric definitions by traversing the CIM_MetricDefForME association.

By traversing the CIM_MetricForME association, a Management Function retrieves all metrics currently available for a given SDC_FluidMeasurementPoint instance.

The TimeStamp and Duration Properties shall be provided for all metrics where the CIM_BaseMetricDefinition.TimeScope is equal to "Interval" (3).

5.2.9.1 Interval metrics

Interval metrics shall be used as metrics where the value applies to a time interval, e.g. the average temperature over a given interval. For interval metrics, CIM_BaseMetricDefinition.TimeScope Property value shall be equal to "Interval" (3). CIM_BaseMetricValue.TimeStamp and CIM_BaseMetricValue.Duration allow the Management Function to evaluate over which interval the metric was computed.

5.2.9.1.1 AverageTemperature

AverageTemperature metric shall be used to measure average temperature at the measuring point during a given demand interval. Table 6 specifies the requirements on the CIM_BaseMericDefinition instance for AverageTemperature metric.

Table 6 — CIM_BaseMetricDefinition instance for AverageTemperature metric

Properties	M/O	Requirements on value
Id	Mandatory	**Key**
Name	Mandatory	"SDC:AverageTemperature "
Description	Optional	"SDC standard metric for average temperature at the measuring point during the interval."
DataType	Mandatory	5 (real64)
Units	Optional	"C"
ProgrammaticUnits	Mandatory	"degree Celcius"
IsContinuous	Mandatory	TRUE
ChangeType	Mandatory	4 (Gauge)
TimeScope	Mandatory	3 (Interval)
GatheringType	Mandatory	3 (Periodic)

5.2.9.1.2   AverageHumidity

AverageHumidity metric shall be used to measure average temperature at the measuring point during a given demand interval. Table 7 specifies the requirements on the CIM_BaseMericDefinition instance for AverageHumidity metric.

Table 7 — CIM_BaseMetricDefinition instance for AverageHumidity metric

Properties	M/O	Requirements on values
Id	Mandatory	**Key**
Name	Mandatory	"SDC:AverageHumidity"
Description	Optional	"SDC standard metric for average humidity at the measuring point during the interval."
DataType	Mandatory	5 (real64)
Units	Optional	"%"
ProgrammaticUnits	Mandatory	"percent"
IsContinuous	Mandatory	TRUE
ChangeType	Mandatory	4 (Gauge)
TimeScope	Mandatory	3 (Interval)
GatheringType	Mandatory	3 (Periodic)

5.2.9.2   Point metrics

5.2.9.2.1   Temperature

Temperature metric shall be used to measure the temperature at a given instant. Table 8 specifies the requirements on the CIM_BaseMericDefinition instance for Temperature metric.

Table 8 — CIM_BaseMetricDefinition instance for Temperature metric

Properties	M/O	Requirements on value
Id	Mandatory	**Key**
Name	Mandatory	"SDC:Temperature"
Description	Optional	"SDC standard metric for temperature at the measuring point at a given point in time."
DataType	Mandatory	5 (real64)
Units	Optional	"C"
ProgrammaticUnits	Mandatory	"degree Celcius"
IsContinuous	Mandatory	TRUE
ChangeType	Mandatory	3 (Gauge)
TimeScope	Mandatory	2 (Point)
GatheringType	Mandatory	4 (OnRequest)

5.2.9.2.2 Humidity

Humidity metric shall be used to measure the humidity at a given instant. Table 9 specifies the requirements on the CIM_BaseMericDefinition instance for Humidity metric.

Table 9 — CIM_BaseMetricDefinition instance for Humidity metric

Properties	M/O	Requirements on value
Id	Mandatory	**Key**
Name	Mandatory	"SDC:Humidity"
Description	Optional	"SDC standard metric for humidity at the measuring point at a given point in time."
DataType	Mandatory	5 (real64)
Units	Optional	"%"
ProgrammaticUnits	Mandatory	"percent"
IsContinuous	Mandatory	TRUE
ChangeType	Mandatory	3 (Gauge)
TimeScope	Mandatory	2 (Point)
GatheringType	Mandatory	4 (OnRequest)

5.2.10 CIM_NumericSensor

CIM_NumericSensor is specified in *Sensors Profile* (DSP1009) and may be used to measure various values including input power of servers. Figure 5 specifies the class diagram of CIM_NumericSensor.
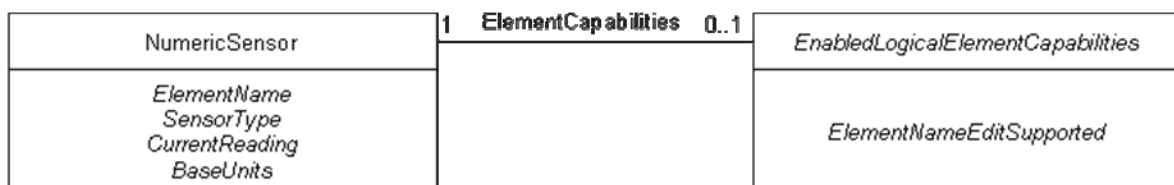
Figure 5 — class: CIM_NumericSensor

5.2.11 CIM_EnabledLogicalElementCapabilities

CIM_EnabledLogicalElementCapabilities class is specified in *Sensors Profile* (DSP1009) and shall be used to indicate support for managing the state of the system.

5.2.12 CIM_ElementCapabilities

CIM_ElementCapabilities association is specified in *Sensors Profile* (DSP1009) and shall be used to associate CIM_NumericSensor with an instance of CIM_EnabledLogicalElementCapabilities that describes the capabilities of CIM_NumericSensor.

5.3 IT Domain

The IT Domain has a set of CIM classes as specified in Table 10, Figure 6, Figure 7 and Figure 8. CIM classes in the IT Domain shall be used to express the IT perspective of Resources.

Table 10 — CIM classes of IT Domain

Class/Association	Reference
CIM_ComputerSystem	DSP1052
CIM_HostedDependency	DSP1052
CIM_HostedService	DSP1042, DSP1081
CIM_ServiceAffectsElement	DSP1081
CIM_VirtualSystemMigrationService	DSP1081
CIM_VirtualSystemManagementService	DSP1042
CIM_Rack	DSP1011
CIM_Chassis	DSP1011
CIM_ChassisInRack	DSP1011
CIM_ComputerSystemPackage	DSP1011
CIM_SystemDevice	DSP1052
CIM_ElementCapabilities	DSP1057
CIM_Processor	DSP1022
CIM_ProcessorCore	DSP1022
CIM_ConcreteComponent	DSP1022
CIM_Processor(virtual)	DSP1044
CIM_OperatingSystem	DSP1029
CIM_RunningOS	DSP1029
CIM_StorageVolume	DSP1047
CIM_BlockStorageStaticalData	DSP1047
CIM_ElementStatisticalData	DSP1035
CIM_NetworkPort	DSP1035
CIM_NetworkPortStatistics	DSP1035
CIM_VirtualComputerSystem	DSP1057
CIM_VirtualSystemSettingData	DSP1052
CIM_VirtualSystemSettingDataComponent	DSP1052
CIM_ResourceAllocationSettingData	DSP1052
CIM_SettingsDefineState	DSP1052

CIM_ResourcePool	DSP1044, DSP1045, DSP1047
CIM_ElementAllocatedFromPool	DSP1044, DSP1045, DSP1047
CIM_Memory	DSP1045
CIM_LogicalDisk	DSP1047
CIM_StorageAllocationSettingData	DSP1047
CIM_EthernetPort	DSP1014
CIM_EthernetPortAllocationSettingData	DSP1014
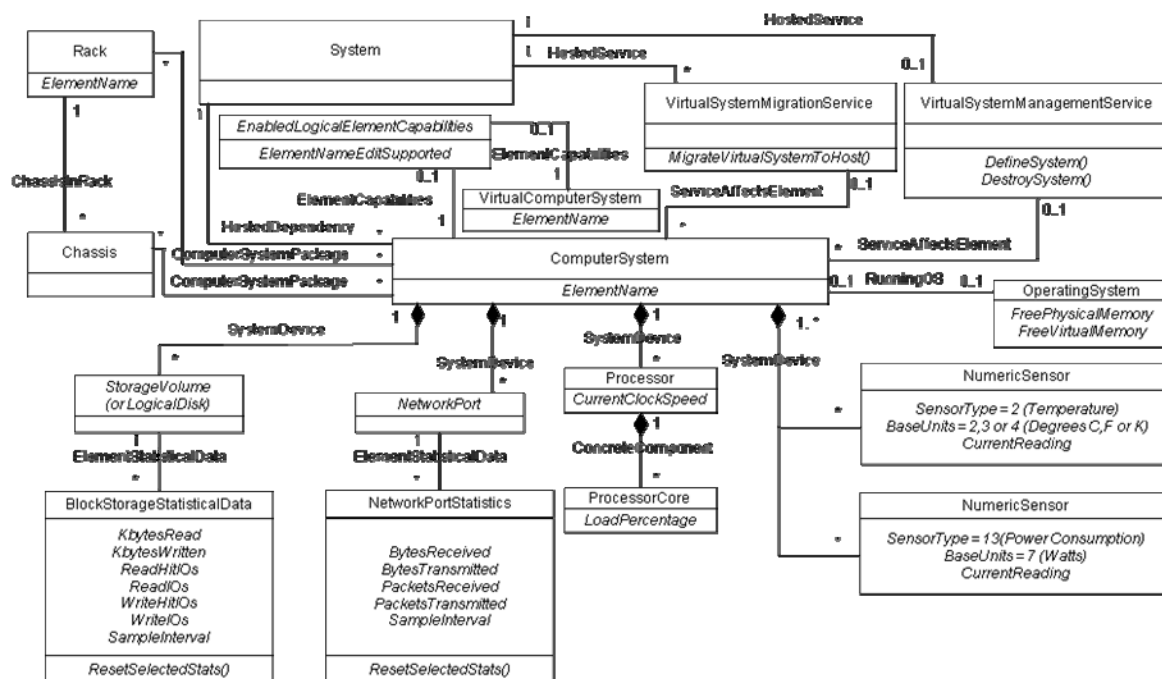
Figure 6 — IT Domain class schema(1)
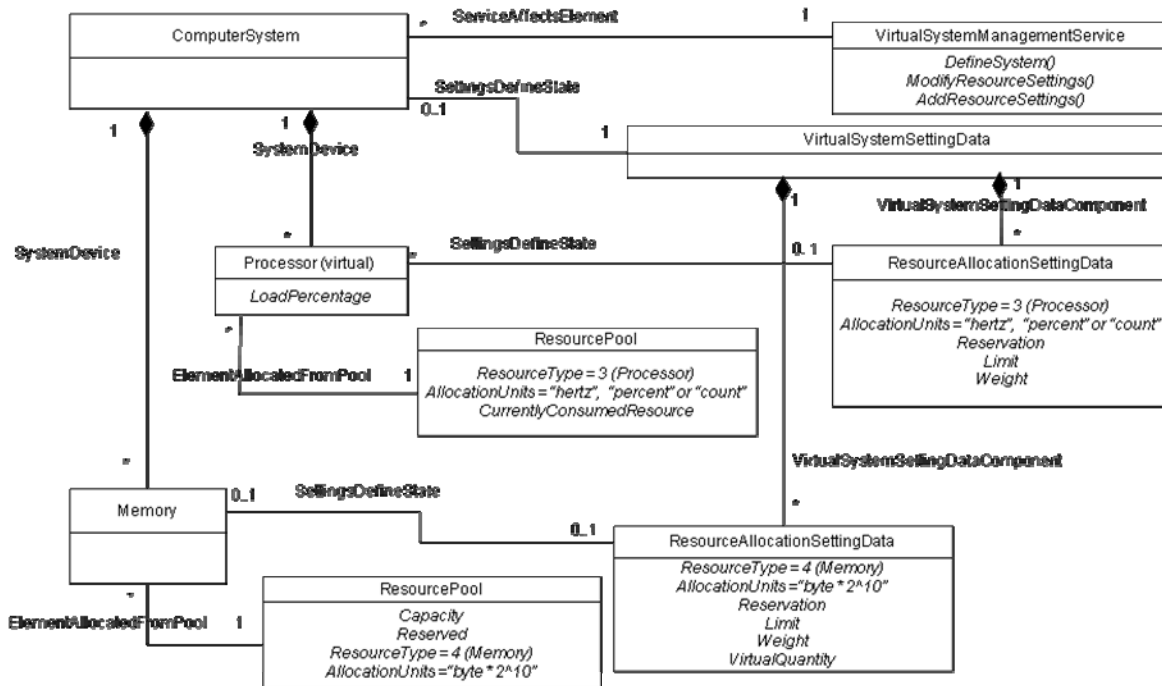
Figure 7 — IT Domain class schema(2)
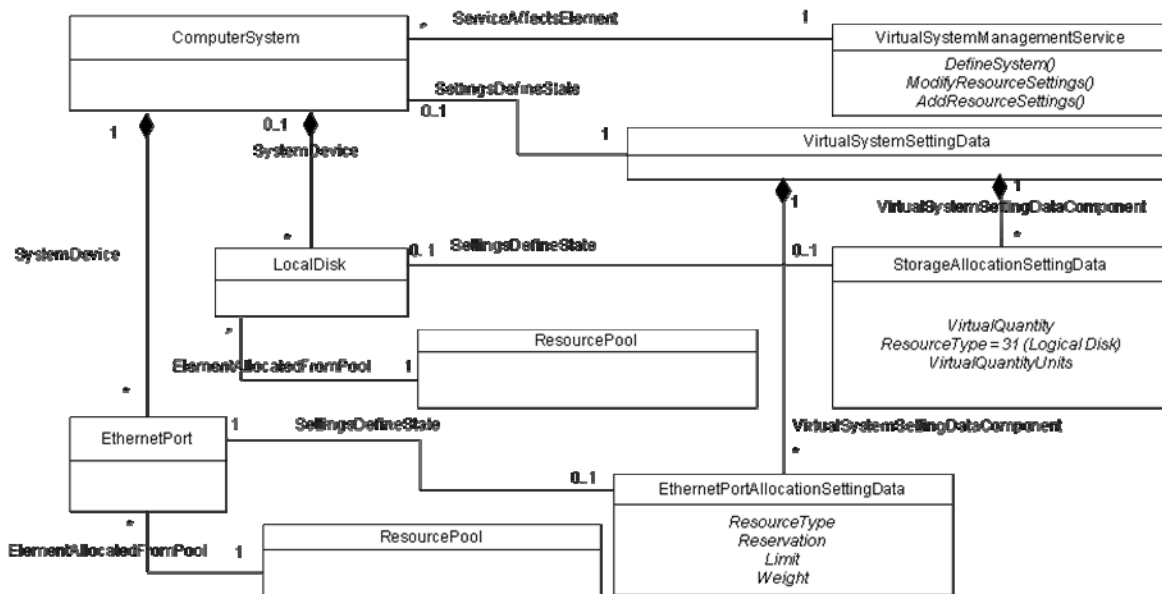
Figure 8 — IT Domain class schema(3)

5.4 Power Domain

The power Domain has a set of CIM classes as specified in Table 11 and Figure 9. CIM classes in the power Domain shall be used to express the power perspective of Resources.

Table 11 — CIM classes of power Domain

Class/Association	Reference
CIM_PowerManagementService	DSP1027
CIM_AssosatedPowerManagementService:PowerState	DSP1027
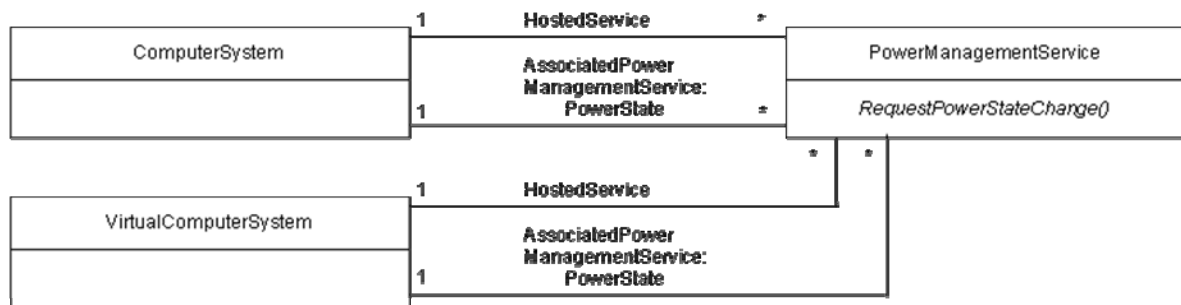
Figure 9 — Power Domain class schema

5.5   Fluid Domain

The fluid Domain has a set of CIM classes to express the fluid perspective of Resources.

The fluid Domain classes shall be used to construct a topology of SDC_FluidElements concerned with thermal energy flows. Annex B shows examples of such topologies.

Figure 10 represents the class schema for the fluid Domain. For simplicity, the prefix CIM_, or SDC_ has been removed from the names of the classes.
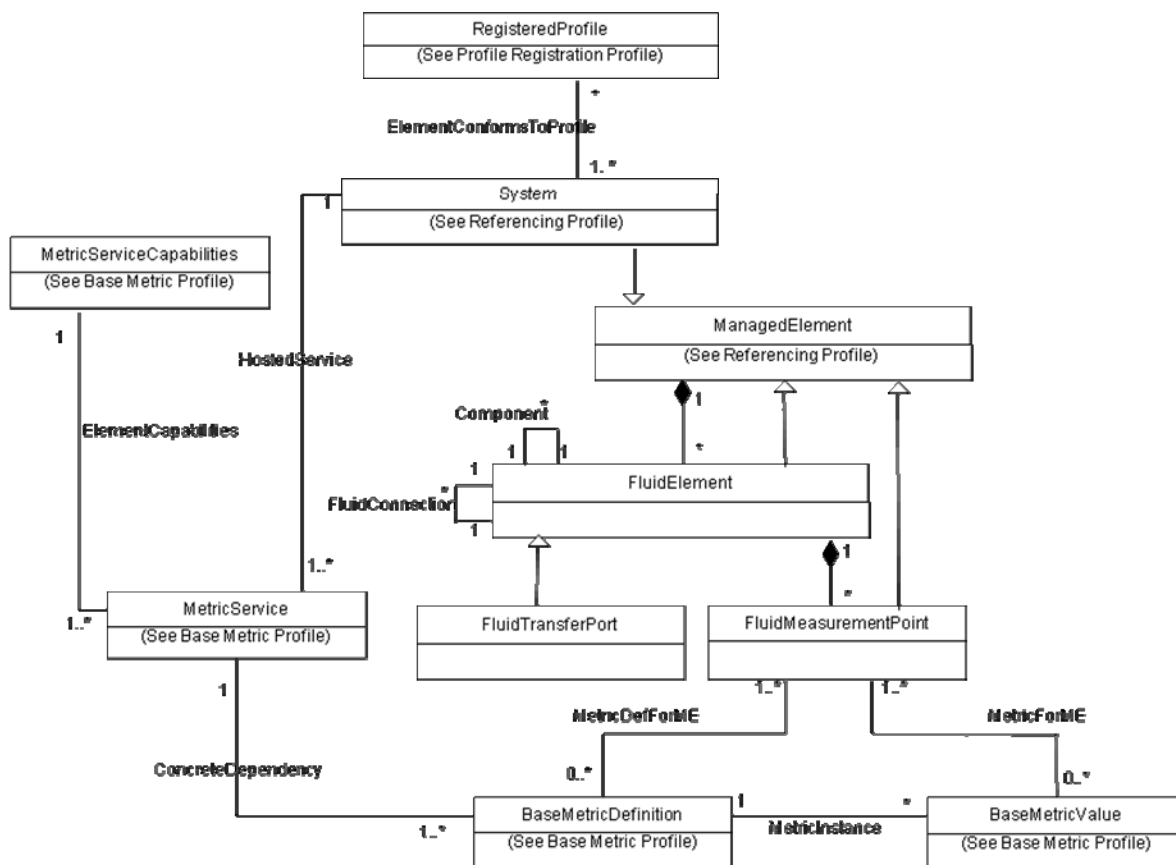
Figure 10 — Fluid Domain class schema

An instance of CIM_System represents a piece of cooling facilities. The requirements on this instance are specified in this document. There may also be an instance of CIM_System representing a larger system of which the cooling system is a part. Requirements on this other instance of CIM_System are out of the scope of this schema.

SDC_FluidMeasurementPoint represents a point to measure fluid flowing through the SDC_FluidElement.

CIM_RegisteredProfile represents the advertisement of the implementation of this schema.

Instances of CIM_BaseMetricDefinition are associated to instances of SDC_FluidMeasurementPoint through the CIM_MetricDefForME association. The metric definition instances contain semantic information data and meta information on metrics. Instances of this class are defined later in this schema. The individual metric values are contained in CIM_BaseMetricValue instances.

Figure 11 represents CIM schema of cooling system. In Figure 11, SDC_CoolingSettingData represents generic setting parameter for a cooling system.
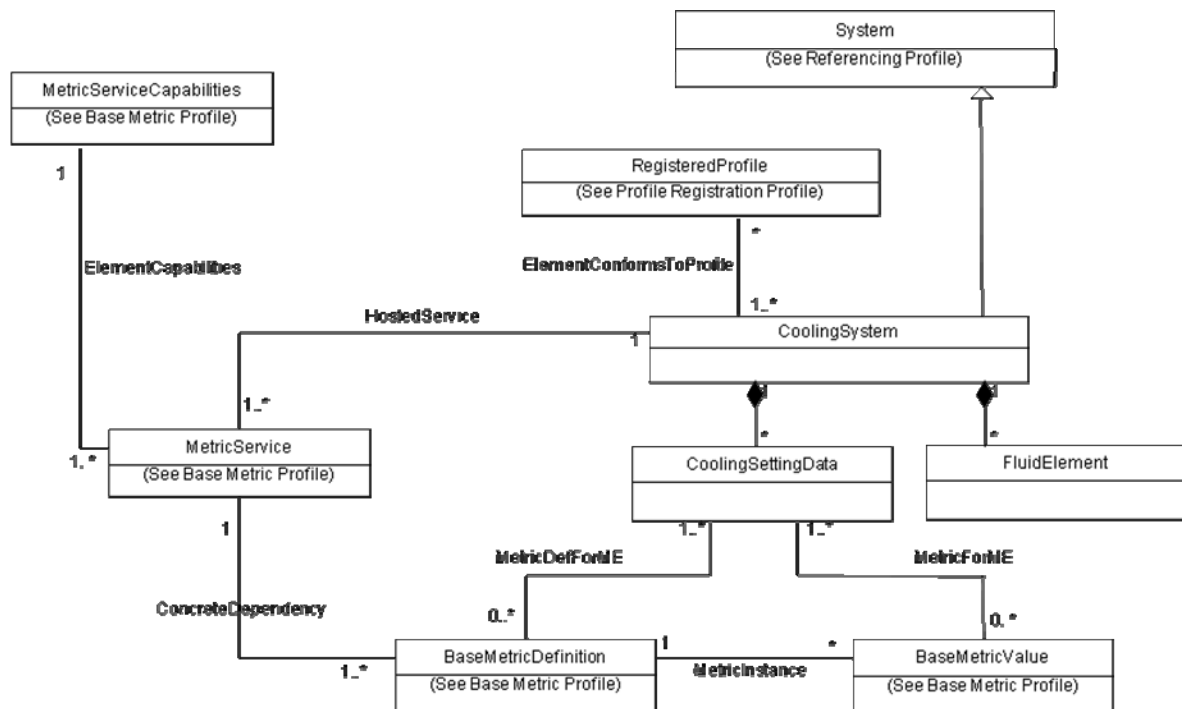
Figure 11 — Cooling system class schema

5.5.1 SDC_FluidConnection

SDC_FluidConnection shall be used to associate SDC_FluidElement to another SDC_FluidElement. The source of fluid flow shall be the Antecedent reference. The destination of fluid flow shall be the Dependent reference. Table 12 details the requirements for instances of SDC_FluidConnection.

Table 12 — Class: SDC_FluidConnection

Properties	M/O	Requirements on value
Antecedent	Mandatory	**Key**: Shall be a reference to SDC_FluidElement instance depending upon the direction of fluid flow with Cardinality 1 indicating one reference
Dependent	Mandatory	**Key**: Shall be a reference to SDC_FluidElement instance depending upon the direction of fluid flow with Cardinality 1..* indicating one or more references

5.5.2 SDC_FluidElement

SDC_FluidElement shall be used to represent logical Properties of a fluid element. A fluid element serves as a source, sink, or conveyor of a fluid. The element may or may not do work on the fluid or extract energy from the fluid. The element may or may not conserve mass flow -- i.e. it may include fluid storage. A fluid element may include other fluid elements internally as components.

SDC_FluidElement is a subclass of CIM_LogicalDevice. One or more SDC_FluidElement instances shall be associated with one instance of CIM_ComputerSystem through an instance of the CIM_SystemDevice association.

SDC_FluidElement may have SDC_FluidMeasurementPoint.

Additionally an instance of SDC_FluidElement may be associated to other instances of SDC_FluidElement through an instance of the SDC_FluidConnection association to represent the fluid flow internal to the SDC_FluidElement.

5.5.3 SDC_FluidMeasurementPoint

SDC_FluidMeasurementPoint shall be used to represent logical Properties of a generic measurement point in the cooling facility where fluid metrics can be measured.

5.5.4 SDC_FluidTransferPort

SDC_FluidTransferPort is a subclass of SDC_FluidElement. SDC_FluidTransferPort shall be used to represent a specific port on the periphery of a SDC_FluidElement where a fluid enters or leaves the SDC_FluidElement. A connection may be made to the external side of a SDC_FluidTransferPort.

5.5.5 SDC_CoolingSystem

SDC_CoolingSystem shall be used to represent logical Properties of a cooling system. SDC_CoolingSystem may have SDC_CoolingSettingData.

5.5.6 SDC_CoolingSettingData

SDC_CoolingSettingData shall be used to represent a generic cooling setting. SDC_CoolingSettingData may include temperature set point and humidity set point.

6   Properties

Management Functions use Messages (Clause 7) to monitor and control Properties specified herein of a Resource. Available Properties are listed in Table 13, Table 14, Table 15 and Table 16. In the tables, "G/S", "G", "S" indicate a Property that may be used in a GET and SET, GET, SET command respectively.

Table 13 — Base Domain Properties

Property Name	Description	G/S
	CIM Class/Association/Property/Method	
Resource ID	Uniquely identifies a Resource	G/S
	ElementName	
	For example, a rack, a server, a VM and an air conditioner are identified by CIM_Rack.ElementName, CIM_ComputerSystem.ElementName, CIM_VirtualComputerSystem.ElementName and SDC_FluidElement.ElementName, respectively.	
	The CIM_EnabledLogicalElementCapabilities instance that is associated with the CIM_ComputerSystem, CIM_VirtualComputerSystem, etc. instance shall have property and value below. CIM_EnabledLogicalElementCapabilities.ElementNameEditSupported = "TRUE"	
Sensor value	Values that this sensor senses	G
	CIM_NumericSensor.CurrentReading	
	The instance shall have properties below. CIM_NumericSensor.SensorType CIM_NumericSensor.BaseUnits	

Table 14 — IT Domain Properties

Property Name	Description	G/S
	CIM Class/Association/Property/Method	
VM Allocation	Tuples of server and VM.	G/S
	VMs shall be (re)allocated to the server indicated in the SET command. SET command has 2 parameters of server and VM. If the first parameter is empty, the VM in the second parameter shall be deleted. If the both parameters are not empty, the VM in the second parameter shall be migrated according to the first parameter.	
	CIM_HostedDependency	
Average load percentage	Average load percentage of this core over the last minute	G
	CIM_ProcessorCore.LoadPercentage [PUnit[1]: percent]	
Current clock speed	Current clock speed of this core	G
	CIM_Processor.CurrentClockSpeed [PUnit[1]: hertz * 10^6]	
Free physical memory	Size of physical memory currently unused and available	G
	CIM_OperatingSystem.FreePhysicalMemory [PUnit[1]: byte * 2^10]	
Free virtual memory	Size of virtual memory currently unused and available. For example, this may be calculated by adding the amount of free RAM to the amount of free paging space	G
	CIM_OperatingSystem.FreeVirtualMemory [PUnit[1]: byte * 2^10]	
Kbytes read	Cumulative count of data read	G

	KbytesRead	
	In the case that this Resource is a Disk and vDisk, the following properties shall be used, respectively. CIM_BlockStorageStatisticalData.KbytesRead [PUnit[1]: byte * 10^3] CIM_BlockStorageStatisticalData.KbytesRead [Units: KiloBytes]	
Kbytes written	Cumulative count of data written	G
	KbytesWritten	
	In the case that this Resource is a Disk and vDisk, the following properties shall be used, respectively. CIM_BlockStorageStatisticalData.KbytesWritten [PUnit[1]: byte * 10^3] CIM_BlockStorageStatisticalData.KbytesWritten [Units: KiloBytes]	
Read hit IOs	Cumulative count of all read cache hits	G
	CIM_BlockStorageStatisticalData.ReadHitIOs	
Read IOs	Cumulative count of all reads	G
	CIM_BlockStorageStatisticalData.ReadIOs	
Duration	Time over which the other values are accumulated	G/S
	SampleInterval [Data Type: datetime]	
	For storage systems and network systems, CIM_BlockStorageStatisticalData.SampleInterval and CIM_NetworkPortStatistics.SampleInterval shall be used, respectively.	
	If the statistics are not sampled at consistent time intervals, SampleInterval shall be set to a zero time interval. Duration shall be expressed as follows. delta CIM_BlockStorageStatisticalData.StatisticTime [DataType: datetime]	
Write hit IOs	Cumulative count of write cache hits	G
	CIM_BlockStorageStatisticalData.WriteHitIOs	
Write IOs	Cumulative count of all writes	G
	CIM_BlockStorageStatisticalData.WriteIOs	
Bytes received	Total number of bytes that are received.	G
	BytesReceived	
	In the case that this Resource is a Network and vNetwork, the following properties shall be used, respectively. CIM_NetworkPortStatistics.BytesReceived [PUnit[1]: byte] CIM_NetworkPortStatistics.BytesReceived [Units: Bytes]	
Bytes transmitted	Total number of bytes that are transmitted	G
	BytesTransmitted	
	In the case that this Resource is a Network and vNetwork, the following properties shall be used, respectively. CIM_NetworkPortStatistics.BytesTransmitted [PUnit[1]: byte] CIM_NetworkPortStatistics.BytesTransmitted [Units: Bytes]	
Packets received	Total number of packets that are received	G
	CIM_NetworkPortStatistics.PacketesReceived	

Packets transmitted	Total number of packets that are transmitted	G
	CIM_NetworkPortStatistics.PacketsTransmitted	
Reservation	Specifies the amount of the resource guaranteed to be available for the VM	G/S
	CIM_ResourceAllocationSettingData.Reservation	
	The instance shall have properties and values below. CIM_ResourceAllocationSettingData.ResourceType = 3 (Processor) CIM_ResourceAllocationSettingData.AllocationUnits = "hertz", "percent" or "count" or a multiple of the units expressed through a regular expression.	
Limit	Specifies the upper bound of the resource that will be granted for the VM	G/S
	CIM_ResourceAllocationSettingData.Limit	
	The instance shall have properties and values below. CIM_ResourceAllocationSettingData.ResourceType = 3 (Processor) CIM_ResourceAllocationSettingData.AllocationUnits = "hertz", "percent" or "count" or a multiple of the units expressed through a regular expression	
Load percentage	Load percentage of this vCPU, averaged over the last minute, in Percent of maximum capability.	G
	CIM_Processor.LoadPercentage [PUnit[1]: percent]	
Current clock speed	Current clock speed of this vCPU	G
	CIM_ResourcePool.CurrentlyConsumedResource	
	The instance shall have properties and values below. CIM_ResourcePool.ResourceType = 3 (Processor) CIM_ResourcePool.AllocationUnits = "hertz", "percent" or "count" or a multiple of the units expressed through a regular expression	
Weight	Relative priority for this allocation in relation to other allocations	G/S
	CIM_ResourceAllocationSettingData.Weight	
	In the case that this Resource is a vCPU, vMemory and vNetwork, the instance shall have properties and values below, respectively. CIM_ResourceAllocationSettingData.ResourceType = 3 (Processor) CIM_ResourceAllocationSettingData.ResourceType = 4 (Memory) CIM_EthernetPortAllocationSettingData.ResourceType = 10 (Ethernet Adapter), 30 (Ethernet Switch Port) or 33 (Ethernet Connection)	
Free physical memory	Size of physical memory currently unused and available	G
	CIM_ResourcePool. Capacity – CIM_ResourcePool.Reserved	
	The instance shall have properties and values below. CIM_ResourcePool.ResourceType = 4 (Memory) CIM_ResourcePool.AllocationUnits = "byte * 2^10"	
Maximum resource	Upper bound, or maximum amount of resource that will be granted for this allocation	G/S
	CIM_ResourceAllocationSettingData.Limit	
	In the case that this Resource is a vMemory, the instance shall have properties and values below. CIM_ResourceAllocationSettingData.ResourceType = 4 (Memory) CIM_ResourceAllocationSettingData.AllocationUnits = "byte * 2^10"	
	In the case that this Resource is a vNetwork, the instance shall have	

	properties and values below. CIM_EthernetPortAllocationSettingData.ResourceType = 10 (Ethernet Adapter), 30 (Ethernet Switch Port) or 33 (Ethernet Connection) CIM_EthernetPortAllocationSettingData.AllocationUnits = "bits per second" or "count" or a multiple of the units expressed through a regular expression	
Minimum resource	Amount of resource guaranteed to be available for this allocation	G/S
	CIM_ResourceAllocationSettingData.Reservation	
	In the case that this Resource is a vMemory, the instance shall have properties and values below. CIM_ResourceAllocationSettingData.ResourceType = 4 (Memory) CIM_ResourceAllocationSettingData.AllocationUnits = "byte * 2^10"	
	In the case that this Resource is a vNetwork, the instance shall have properties and values below. CIM_EthernetPortAllocationSettingData.ResourceType = 10 (Ethernet Adapter), 30 (Ethernet Switch Port) or 33 (Ethernet Connection) CIM_EthernetPortAllocationSettingData.AllocationUnits = "bits per second" or "count" or a multiple of the units expressed through a regular expression	
Physical memory size	The total amount of physical memory	G/S
	CIM_ResourceAllocationSettingData.VirtualQuantity	
	The instance shall have properties and values below. CIM_ResourceAllocationSettingData.ResourceType = 4 (Memory) CIM_ResourceAllocationSettingData.AllocationUnits = "byte * 2^10"	
Time counter	Cumulative time	G/S
	SampleInterval [Data Type: datetime]	
	In the case that this Resource is a vDisk and a vNetwork, the following properties shall be used, respectively. CIM_BlockStorageStatisticalData.SampleInterval [Data Type: datetime] CIM_NetworkPortStatistics.SampleInterval [DataType: datetime]	
	If the statistics are not sampled at consistent time intervals,SampleInterval shall be set to a zero time interval.Duration shall be expressed as follows. delta CIM_BlockStorageStatisticalData.StatisticTime	
Total disk size	The total amount of vDisk	G/S
	CIM_StorageAllocationSettingData.VirtualQuantity	
	The instance shall have properties and values below. CIM_StorageAllocationSettingData.ResourceType = 31 (Logical Disk) CIM_StorageAllocationSettingData.VirtualQuantityUnits [count (fixed size block)]	
Network bandwidth	Maximum speed of vNetwork	G/S
	CIM_EthernetPortAllocationSettingData.Limit	
	The instance shall have properties and values below. CIM_EthernetPortAllocationSettingData.ResourceType = 10 (Ethernet Adapter), 30 (Ethernet Switch Port) or 33 (Ethernet Connection) CIM_EthernetPortAllocationSettingData.AllocationUnits = "bits per second" or "count" or a multiple of the units expressed through a regular expression	

	or	
	CIM_ResourcePool.Capacity	
	The instance shall have properties and values below. CIM_ResourcePool.ResourceType = 10 (Ethernet Adapter), 30 (Ethernet Switch Port) or 33 (Ethernet Connection) CIM_ResourcePool.AllocationUnits = "bits per second" or "count" or a multiple of the units expressed through a regular expression	

1 PUnit stands for a Programmatic Unit, which is an expression of a unit of measure for programmatic access.

Table 15 — Power Domain Properties

Property Name	Description	G/S
	CIM Class/Association/Property/Method	
Input power	Input power of this Resource	G
	CIM_NumericSensor.CurrentReading	
	In the case that this Resource is a server, a chassis, or a rack, the instance shall have properties and values below. CIM_NumericSensor.SensorType = 13 (Power Consumption). CIM_NumericSensor.BaseUnits = 7 (Watts)	
Power status	Power status of this Resource, e.g., Active or Off. In case that this Resource is a server or a VM, the status shall be those specified in ENERGY STAR (R) Program Requirements for Computers version 5.0, e.g., Active, Idle, Sleep or Off.	G/S
	CIM_AssociatedPowerManagementService.PowerState	
	The property value can be modified with extrinsic methods, such as CIM_PowerManagementService.RequestPowerStateChange().	

Table 16 — Fluid Domain Properties

Property Name	Description	G/S
	CIM Class/Association/Property/Method	
Inlet air temperature	Temperature of the air suctioned into this Resource	G
	CIM_NumericSensor.CurrentReading	
	In the case that this Resource is a server, a chassis, or a rack, the instance shall have properties and values below. CIM_NumericSensor.SensorType = 2 (Temperature). CIM_NumericSensor.BaseUnits = 2 (Degrees C), 3 (Degrees F) or 4 (Degrees K)	
Supply air temperature	Temperature of the air supplied to the room/floor chamber from this A/C	G
	CIM_BaseMetricValue.MetricValue	
	The instance shall have properties and values below. CIM_BaseMetricDefinition.ProgrammaticUnits = degree Celsius,degree Fahrenheit or Kelvin CIM_BaseMetricDefinition.Description = "Supply air temperature"	
Return air temperature	Temperature of the air suctioned from the room into the return grill on this A/C	G

	CIM_BaseMetricValue.MetricValue The instance shall have properties and values below. CIM_BaseMetricDefinition.ProgrammaticUnits = degree Celsius,degree Fahrenheit or Kelvin CIM_BaseMetricDefinition.Description = "Return air temperature"	
Set temperature	Value set to this A/C as supply air temperature, return air temperature or room temperature	G/S
	CIM_BaseMetricValue.MetricValue The instance shall have properties and values below. CIM_BaseMetricDefinition.ProgrammaticUnits = degree Celsius,degree Fahrenheit or Kelvin CIM_BaseMetricDefinition.Description = "Set temperature"	
Outdoor air temperature	Temperature of the environment around the outdoor unit of this A/C	G
	CIM_BaseMetricValue.MetricValue The instance shall have properties and values below. CIM_BaseMetricDefinition.ProgrammaticUnits = degree Celsius, degree Fahrenheit or Kelvin CIM_BaseMetricDefinition.Description = "Outdoor air temperature"	
Supply air humidity	Humidity of the air supplied to the room/floor chamber from this A/C	G
	CIM_BaseMetricValue.MetricValue The instance shall have properties and values below. CIM_BaseMetricDefinition.ProgrammaticUnits = percent CIM_BaseMetricDefinition.Description = "Supply air humidity"	
Return air humidity	Humidity of the air suctioned from the room into the return grill on this A/C	G
	CIM_BaseMetricValue.MetricValue The instance shall have properties and values below. CIM_BaseMetricDefinition.ProgrammaticUnits = percent CIM_BaseMetricDefinition.Description = "Return air humidity"	
Set humidity	Value set to this A/C as supply air humidity, return air humidity or room humidity	G/S
	CIM_BaseMetricValue.MetricValue The instance shall have properties and values below. CIM_BaseMetricDefinition.ProgrammaticUnits = percent CIM_BaseMetricDefinition.Description = "Set humidity"	

7   Messages

Messages represent commands, responses or events. Management Functions use Messages to monitor and control Resources. Messages are CIM message requests and responses as specified in *CIM Operations over HTTP* (DSP0200). This Clause specifies requests and responses in pairs; each received request requires a response as specified in DSP0200. A Management Function uses a CIM Listener and a CIM Client to send and receive Messages. Resources use a CIM Server, which implements the HTTP server, to send and receive Messages.

Properties of a Resource are represented as Properties of an instance of a CIM class. Management Function shall have information of the instance name and the CIM Server that represents a Resource to query the properties of the Resource.

To query Properties of a Resource, Management Functions shall include the corresponding instance name and the CIM Server that represents the Resource in CIM messages. The CIM Server shall respond a CIM message request as a proxy for the Resource. Unimplemented Properties or Event Conditions shall be signalled in responses that carry "CIM_ERR_NO_SUCH_PROPERTY" or "CIM_ERR_NOT_FOUND" error codes respectively.

7.1 Commands and responses

7.1.1 GET

7.1.1.1 GET command

GET command specified in the table below shall be used to request Resource Properties or Event Descriptions. GET command shall be issued by Management Function and be received by Resource.

Item		Corresponding CIM-XML header
Message type		<IMETHODCALL NAME="GetProperty">
Request ID		<MESSAGE ID="Request ID">
Object data	Target	<IPARAMVALUE NAME = "InstanceName"> <IPARAMVALUE NAME = "PropertyName">

7.1.1.2 GET response

GET response specified in the table below is the response to the GET command. GET response is issued by Resource and is received and processed by Management Function.

Item		Corresponding CIM-XML header
Message type		<IMETHODRESPONSE NAME="GetProperty">
Request ID		<MESSAGE ID="Request ID">
Result code		<IRETURNVALUE> (indicating success) or <ERROR Code="error code"> (indicating error)
Object data	Target	Not specified in GET response (Target of the received GET command)
	Value	<IRETURNVALUE> <VALUE>"Value"</VALUE> </IRETURNVALUE>

7.1.2 SET

7.1.2.1 SET command

SET command shall include the following items to set Properties of Resources or to set Event Conditions. SET command is issued by Management Function and is received and processed by Resource.

Item		Corresponding CIM-XML header
Message type		<IMETHODCALL NAME="SetProperty">
Request ID		<MESSAGE ID="Request ID">
Object Data	Target	<IPARAMVALUE NAME="InstanceName"> <IPARAMVALUE NAME="PropertyName">
	Value	<IPARAMVALUE NAME="PropertyValue"> <Value>"New Value"</Value> </IPARAMVALUE>

7.1.2.2 SET response

SET response shall include the following items. SET response is issued by Resource and is received and processed by Management Function.

Item	Corresponding CIM-XML header
Message type	<IMETHODCALL NAME="SetProperty">
Request ID	<MESSAGE ID="Request ID">
Result Code	<IRETURNVALUE> (indicating success) or <ERROR Code="error code"> (indicating error)

7.2 Event subscription and notification

7.2.1 Event subscription

To specify the conditions under which Management Functions need to be notified, they shall create an instance of CIM_IndicationFilter as described in *CIM Event Model White Paper* (DSP0107). Management Function issues Event subscription request to Resources that register the Event subscriptions that may result in event notifications. In the table, "M" and "O" indicate a field is mandatory or optional respectively.

Field name	Corresponding property of CIM_IndicationFilter	Dimen sion	G/S	M/O
Event subscription ID	Name	-	G/S	M
Host	SystemCreationClassName, SystemName, CreationClassName	-	G/S	M
Interval	RepeatNotificationPolicy, OtherRepeatNotificationPolicy, RepeatNotificationInterval, RepeatNotificationGap, RepeatNotificationCount	s	G/S	O
Beginning		-	G/S	O
End		-	G/S	O
Conditions	Query, QueryLanguage	-	G/S	M

7.2.2 Event notification

When the Conditions in the Event subscriptions have been met, Resources shall notify the Management Function which registered the Event subscription using the Event notification.

Item		Corresponding CIM-XML header
Message type		<EXPMETHODCALL NAME="ExportIndication"> <EXPPARAMVALUE NAME="NewIndication"> <INSTANCE CLASSNAME="CIM_AlertIndication">
Source		Not specified in Event notification. The identifier of a Resource who sent this event, where the identifier is unique (at least) in SDC
Event subscription ID		<MESSAGE ID="Event subscription ID">
Object Data	Value	<PROPERTY NAME="Description" > <VALUE>"Value"</VALUE> </PROPERTY>
Event Time		<PROPERTY NAME="IndicationTime" TYPE="datetime"> <VALUE>"time"</VALUE> </PROPERTY>

Annex A
(normative)

ECMA-400 Edition 1 Resource configuration options

This Annex specifies Resource configurations of ECMA-400 first edition in terms of Resource Components. Any of these Resource configurations may be optionally implemented, in addition to any other configuration using any combination of Resources and Resource Components.

A.1 SDC VM Allocation Option

Property in Edition 1	Corresponding CIM Class/Property/Method
VM Allocation	CIM_HostedDependency

A.2 SDC Rack Option

Property in Edition 1	Corresponding CIM Class/Property/Method
Rack ID	CIM_Rack.ElementName
Rack input power	Summation of CIM_NumericSensor.CurrentReading of ComputerSystems that are realized in one or more PhysicalPackages, such as Chassis, in a rack.
Rack inlet air temperature	Average of CIM_NumericSensor.CurrentReading of ComputerSystems that are realized in one or more PhysicalPackages, such as Chassis, in a rack.
Rack power status	CIM_AssociatedPowerManagementService.PowerState

A.3 SDC Server Option

Property in Edition 1	Corresponding CIM Class/Property/Method
Server ID	CIM_ComputerSystem.ElementName
Input power	CIM_NumericSensor.CurrentReading
Server inlet air temperature	CIM_NumericSensor.CurrentReading
Server power status	CIM_AssociatedPowerManagementService.PowerState

A.4 SDC CPU/Core Option

Property in Edition 1	Corresponding CIM Class/Property/Method
Average load percentage	CIM_ProcessorCore.LoadPercentage [PUnit: percent]
Current clock speed	CIM_Processor.CurrentClockSpeed [PUnit: hertz * 10^6]

A.5 SDC Memory Option

Property in Edition 1	Corresponding CIM Class/Property/Method
Free physical memory	CIM_OperatingSystem.FreePhysicalMemory [PUnit: byte * 2^10]
Free virtual memory	CIM_OperatingSystem.FreeVirtualMemory [PUnit: byte * 2^10]

A.6 SDC Disk Option

Property in Edition 1	Corresponding CIM Class/Property/Method
Kbytes read	CIM_BlockStorageStatisticalData.KbytesRead [PUnit: byte * 10^3]
Kbytes written	CIM_BlockStorageStatisticalData.KbytesWritten [PUnit: byte * 10^3]
Read hit IOs	CIM_BlockStorageStatisticalData.ReadHitIOs
Read IOs	CIM_BlockStorageStatisticalData.ReadIOs
Duration	CIM_BlockStorageStatisticalData.SampleInterval [Data Type: datetime]
Write hit IOs	CIM_BlockStorageStatisticalData.WriteHitIOs
Write IOs	CIM_BlockStorageStatisticalData.WriteIOs

A.7 SDC Network Option

Property in Edition 1	Corresponding CIM Class/Property/Method
Bytes received	CIM_NetworkPortStatistics.BytesReceived [PUnit: byte]
Bytes transmitted	CIM_NetworkPortStatistics.BytesTransmitted [PUnit: byte]
Packets received	CIM_NetworkPortStatistics.PacketesReceived
Packets transmitted	CIM_NetworkPortStatistics.PacketsTransmitted
Duration	CIM_NetworkPortStatistics.SampleInterval [DataType: datetime]

A.8 SDC VM Option

Property in Edition 1	Corresponding CIM Class/Property/Method
VM ID	CIM_VirtualComputerSystem.ElementName
Power status	CIM_AssociatedPowerManagementService.PowerState

A.9 SDC vCPU Option

Property in Edition 1	Corresponding CIM Class/Property/Method
Reservation	CIM_ResourceAllocationSettingData.Reservation
Limit	CIM_ResourceAllocationSettingData.Limit
Load percentage	CIM_Processor.LoadPercentage [PUnit: percent]
Current clock speed	CIM_ResourcePool.CurrentlyConsumedResource
Weight	CIM_ResourceAllocationSettingData.Weight

A.10 SDC vMemory Option

Property in Edition 1	Corresponding CIM Class/Property/Method
Free physical memory	CIM_ResourcePool.Capacity – CIM_ResourcePool.Reserved
Maximum resource	CIM_ResourceAllocationSettingData.Limit
Minimum resource	CIM_ResourceAllocationSettingData.Reservation
Physical memory size	CIM_ResourceAllocationSettingData.VirtualQuantity
Weight	CIM_ResourceAllocationSettingData.Weight

A.11 SDC vDisk Option

Property in Edition 1	Corresponding CIM Class/Property/Method
Kbytes read	CIM_BlockStorageStatisticalData.KbytesRead [Units: KiloBytes]
Kbytes written	CIM_BlockStorageStatisticalData.KbytesWritten [Units: KiloBytes]
Read hit IOs	CIM_BlockStorageStatisticalData.ReadHitIOs
Read IOs	CIM_BlockStorageStatisticalData.ReadIOs
Time counter	CIM_BlockStorageStatisticalData.SampleInterval [Data Type: datetime]
Total disk size	CIM_StorageAllocationSettingData.VirtualQuantity
Write hit IOs	CIM_BlockStorageStatisticalData.WriteHitIOs
Write IO	CIM_BlockStorageStatisticalData.WriteIOs

A.12 SDC vNetwork Option

Property in Edition 1	Corresponding CIM Class/Property/Method
Bytes received	CIM_NetworkPortStatistics.BytesReceived [Units: Bytes]
Bytes transmitted	CIM_NetworkPortStatistics.BytesTransmitted [Units: Bytes]
Maximum resource	CIM_EthernetPortAllocationSettingData.Limit
Minumum resource	CIM_EthernetPortAllocationSettingData.Reservation
Network bandwidth	CIM_EthernetPortAllocationSettingData.Limit or CIM_ResourcePool.Capacity
Packets received	CIM_NetworkPortStatistics.PacketesReceived
Packets transmitted	CIM_NetworkPortStatistics.PacketsTransmitted
Time counter	CIM_NetworkPortStatistics.SampleInterval [DataType: datetime]
Weight	CIM_EthernetPortAllocationSettingData.Weight

A.13   SDC Air conditioner Option

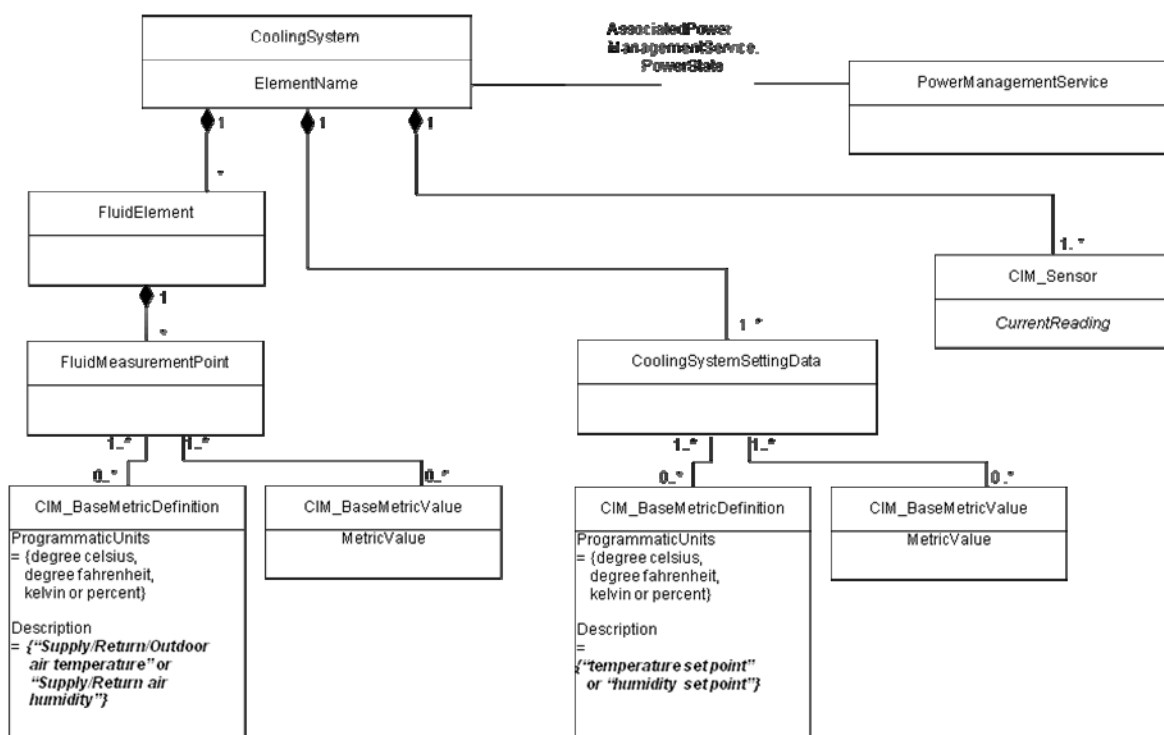| Property in Edition 1	Corresponding CIM Class/Property/Method
Air Conditioner ID	SDC_FluidElement.ElementName
Operation status	CIM_AssociatedPowerManagementService.PowerState
Supply air temperature	CIM_BaseMetricValue.MetricValue
Return air temperature	CIM_BaseMetricValue.MetricValue
Set temperature	CIM_BaseMetricValue.MetricValue
Outdoor air temperature	CIM_BaseMetricValue.MetricValue
Supply air humidity	CIM_BaseMetricValue.MetricValue
Return air humidity	CIM_BaseMetricValue.MetricValue
Set humidity	CIM_BaseMetricValue.MetricValue
Input power	CIM_Sensor.CurrentReading

Figure A.1 — CIM equivalent for SDC Air Conditioner

A.14   SDC Sensor Option

Property in Edition 1	Corresponding CIM Class/Property/Method
Sensor ID	CIM_NumericSensor.ElementName
Sensor value	CIM_NumericSensor.CurrentReading

Annex B
(informative)

Resource configuration of a CRAH system's fluid perspective

This Standard specifies the following classes in addition to the *CIM schema* (DSP0004).

1. SDC_FluidElement (FE)

SDC_FluidElement represents any element that serves as a source, sink, or conveyor of a fluid. The element may or may not do work on the fluid or extract energy from the fluid. The element may or may not conserve mass flow -- i.e. it may include fluid storage. An FE may include other FEs internally as components.

2. SDC_FluidTransferPort (FTP)

SDC_FluidTransferPort represents a specific port on the periphery of a SDC_FluidElement where a fluid enters or leaves the SDC_FluidElement. A connection may be made to the external side of a FTP. SDC_FluidTransferPort is a subclass of SDC_FluidElement.

3. SDC_FluidConnection (FC)

SDC_FluidConnection represents an association which joins two SDC_FluidElements and through which fluid may flow between the elements. The elements may be two FTPs, two FEs, or an FTP and an FE.

4. SDC_FluidMeasurementPoint (FMP)

SDC_FluidMeasurementPoint represents a point to measure fluid flowing through a FTP or a FE.

Figure B.1 illustrates the fluid perspective and property mapping of a CRAH system (Resource topology). This graphical model is directly translated into CIM equivalent representation specified in this Standard.
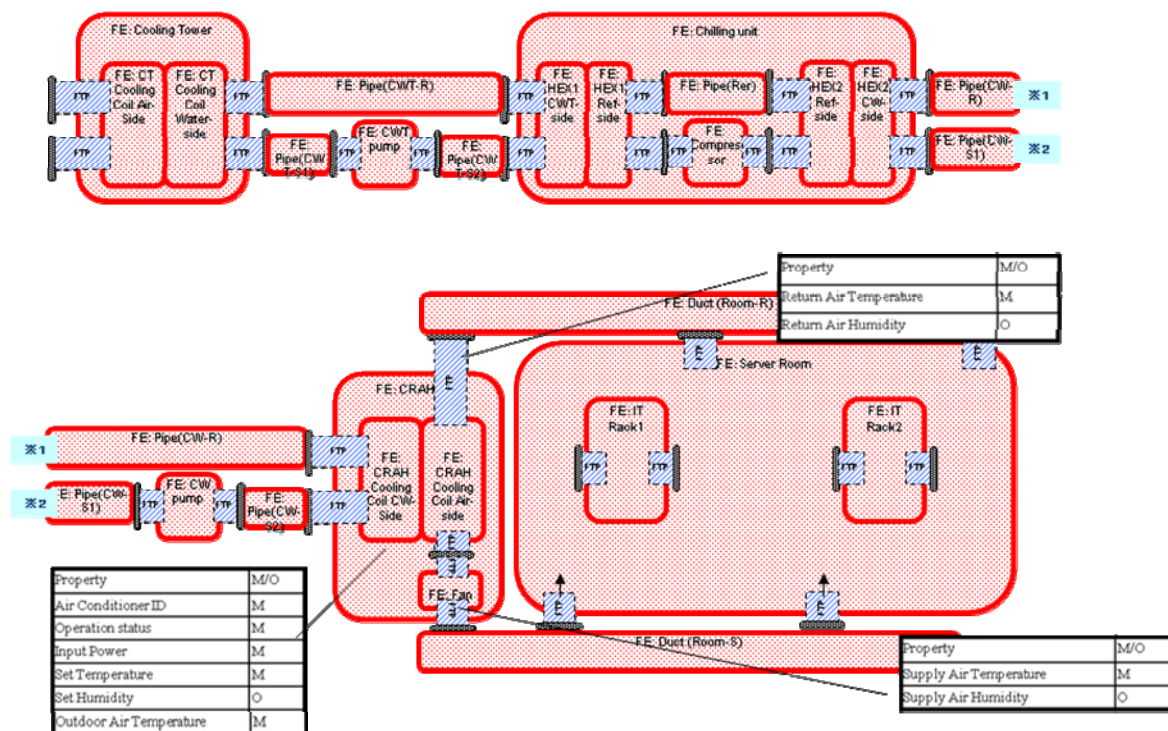
Figure B.1 — Fluid perspective representation of CRAH system