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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Data Solutions (DATA).

The present document is part 15 of a multi-part deliverable covering Data Solutions (DATA); Extension to SAREF, as identified below:

Part 1: "Energy Domain";

Part 2: "Environment Domain";

Part 3: "Building Domain";

Part 4: "Smart Cities Domain";

Part 5: "Industry and Manufacturing Domains";

Part 6: "Smart Agriculture and Food Chain Domain";

Part 7: "Automotive Domain";

Part 8: "eHealth/Ageing-well Domain";

Part 9: "Wearables Domain";

Part 10: "Water Domain";

Part 11: "Lift Domain";

Part 12: "Smart Grid Domain";

Part 13: "Maritime Domain";

Part 14: "Thermal Energy Storage Systems Domain";

Part 15: "Device Management Domain".

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document presents SAREF4DMGT, the SAREF extension for Device Management.

Device Management (DM) refers to the remote administration of devices by operators, such as service providers or manufacturers, to ensure proper functioning, configuration, and support, especially as the scope has expanded with the rise of IoT.

The architecture of device management for operators typically involves DM clients embedded in devices, which expose management functions, and DM servers operated by service providers, which coordinate and execute commands to manage and configure devices remotely.

The emergence of numerous heterogeneous IoT devices and proprietary, siloed management solutions has created a new problem: the need for federating multiple device management systems to achieve interoperability across diverse protocols and device capabilities.

In the Device Management domain, federation refers to the ability to coordinate and execute commands across multiple heterogeneous systems.

To achieve this federation, the current scope of the Ontology comprises three items:

- The representation of the device management capabilities of a device, with their associated functions and commands.
- The representation of the information needed to select which command to execute on a device for a targeted function.
- The representation of the information retrievable from the device and exposed by the DM server.

The proposed ontology defines the required entities, extending the concepts from the SAREF v4.1.1 ontology.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found in the ETSI docbox.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long-term validity.

The following referenced documents are necessary for the application of the present document.

[1] ETSI TS 103 264: "SmartM2M; Smart Applications; Reference Ontology and oneM2M Mapping".

[2] ETSI TS 103 548: "SmartM2M; SAREF reference ontology patterns".

[3] ETSI TS 103 673: "SmartM2M; SAREF Development Framework and Workflow, Streamlining the Development of SAREF and its Extensions".

[4] BBF TR-069 Amendment 6 Corrigendum 1: "Broadband Forum, CPE WAN Management Protocol".

[5] BBF TR-181 Issue 2 Amendment 20 Corrigendum 1: "oneM2M TR-181 Device Data Model for CWMP Endpoints and USP Agents".

[6] BBF TR-369 Issue 1 Amendment 4 Corrigendum 2: "Broadband Forum, The User Services Platform".

[7] OMA-TS-LightweightM2M_Core-V1_2_2-20240613-A: "Lightweight Machine to Machine Technical Specification: Core".

[8] oneM2M TS-0001 (v4.24.0): "Functional Architecture".

[9] oneM2M TS-0005 (v4.0.3): "Management Enablement (OMA)".

[10] oneM2M TS-0006 (v4.0.1): "Management Enablement (BBF)".

[11] oneM2M TS-0014: (v4.0.1) "LwM2M Interworking".

[12] oneM2M TS-0023 (v5.7.0): "SDT based Information Model and Mapping for Vertical Industries", (section 5.8 Device Management).

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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The following referenced documents may be useful in implementing an ETSI deliverable or add to the reader's understanding, but are not required for conformance to the present document.

[i.1] Open Mobile Alliance: "LwM2M Registries, objects and resources".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI TS 103 673 [3] and the following apply:

ontology: formal specification of a conceptualization, used to explicit capture the semantics of a certain reality

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

API	Application Programming Interface
BBF	BroadBand Forum
CWMP	Customer Premises Equipment Wide Area Network Management Protocol
DM	Device Management
IoT	Internet of Things
IRI	Internationalized Resource Identifier
LwM2M	LightWeight Machine-to-Machine
OMA	Open Mobile AllianceOWL Web Ontology Language
OWL-DL	Web Ontology Language Description Logics
SAREF	Smart Applications REFerence ontology
SAREF4DMGT	SAREF extension for Device Management

RDF	Resource Description Framework
TCP	Transmission Control Protocol
TTL	Terse RDF Triple Language (Turtle)
UML	Unified Modeling Language
USP	User Services Platform

4 SAREF4DMGT ontology and semantics

4.1 Introduction and overview

The objective of SAREF4DMGT is to extend the SAREF ontology (see ETSI TS 103 264 [1]) for the Device Management (DM) domain. Clause 4.1 of the present document shortly introduces a high-level view of the envisioned SAREF4DMGT semantic model, with the retained concepts (i.e. classes) and their relations.

The Device Management (DM) domain consists in the remote administration of devices for an operator, such as a service provider or device manufacturer.

The proposal for an ontology for standardization in Device Management is motivated by the need to address challenges arising from the evolution of DM and the emergence of the Internet of Things (IoT).

Initially, DM was introduced by manufacturers and telecommunication operators to ensure the proper functioning of devices like gateways and set-top boxes, focusing on firmware management due to the high replacement costs of these devices. Over time, the scope of DM expanded to include configuration and customer care, enabling Telcos to configure value-added services, improve Quality of Service, and reduce costs.

With the rise of the IoT, the DM landscape has shifted significantly. The proliferation of heterogeneous IoT devices and the temptation to produce disposable devices have highlighted the need for remote management for economic and ecological reasons. However, existing DM solutions face challenges due to the scale and diversity of IoT devices, as well as the prevalence of proprietary protocols and siloed solutions from various manufacturers. This has created issues with heterogeneity in device capabilities, DM protocols, and management solutions.

Standardization becomes essential to simplify device integration and DM operations, benefiting both operators and manufacturers.

The proposed IoT Device Management Ontology provides an abstract semantic model of DM domain-specific concepts, enabling cross-system data interoperability and knowledge enrichment through reasoning. This ontology aims to unify and streamline IoT DM practices, overcoming the limitations of existing approaches.

Therefore, the SAREF4DMGT ontology shall allow:

- The representation of the device management capabilities of a device, with their associated functions and commands.
- The representation of the information needed to select which command to execute on a device for a targeted function.
- The representation of the information retrievable from the device and exposed by the DM server.

The SAREF4DMGT extension has been specified and formalized by investigating Device Management standard protocols, such as BBF CWMP [4], BBF USP [5], oneM2M [6] or OMA LwM2M [7].

SAREF4DMGT mainly reuses the SAREF ontology (see ETSI TS 103 264 [1]) and is developed according to the SAREF Development Framework and Workflow (see ETSI TS 103 673 [3]).

.
The SAREF4DMGT ontology is fully specified and formalized in Clause 4.2 of the present document. Figure 1 presents the high-level view of the envisioned model of SAREF4DMGT ontology. In Figure 1, classes directly imported from the SAREF ontology are in yellow, classes specifically developed for SAREF4DMGT are in blue.

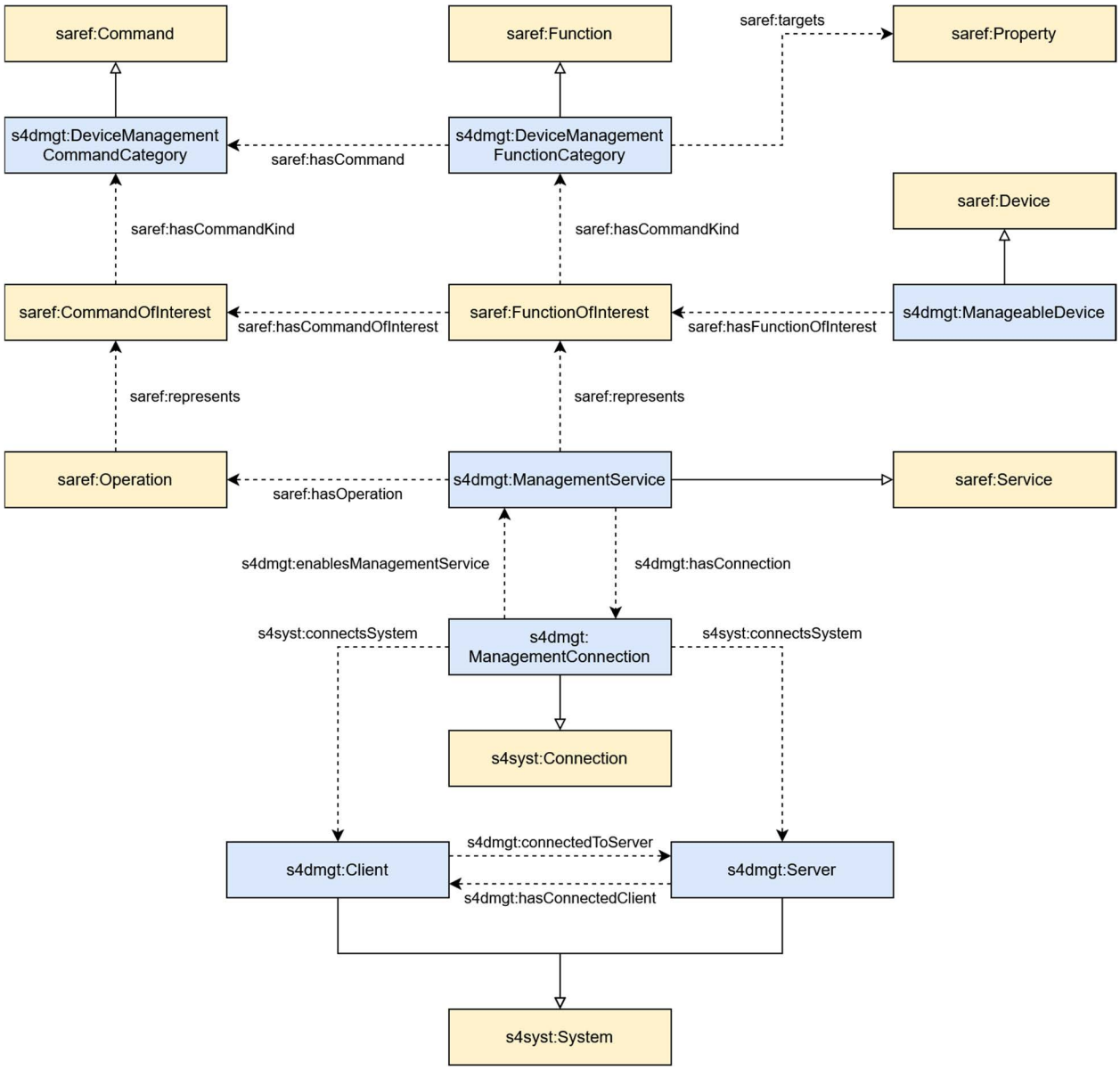

Figure 1: High level view of the envisioned semantic model for the SAREF4DMGT ontology

Within Figure 1, as well as within all the figures that are depicted in Clause 4 of the present document, the following conventions are used:

- arrows are used to represent properties between classes and to represent some RDF, RDF-S and OWL constructs, more precisely:
  - plain arrows with white triangles represent the rdfs:subClassOf relation between two classes. The origin of the arrow is the class to be declared as subclass of the class at the destination of the arrow;
  - dashed arrows between two classes indicate a local restriction in the origin class, i.e. that the object property can be instantiated between the classes in the origin and the destination of the arrow. The identifier of the object property is indicated within the arrow;
  - dashed arrows with no identifier are used to represent the rdf:type relation, indicating that the element in the origin of the arrow is an instance of the class in the destination of the arrow;
- datatype properties are denoted by rectangles attached to the classes, in an UML-oriented way. Dashed boxes represent local restrictions in the class, i.e. datatype properties that can be applied to the class they are attached to;
- individuals are denoted by rectangles in which the identifier is underlined.

SAREF4DMGT is extending the SAREF ontology for the Device Management domain and thus shall logically mainly model the following concepts (i.e. classes within Figure 1):

- Manageable Device: A tangible object that has at least one Device Management Function. This class extends the saref:Device class, it is a Feature of Interest by definition.
- Server: A DM Server is the software entity which is responsible for performing DM operations on a fleet of Devices. It exposes the set of available operations to an entity that needs to trigger an operation, such as a manufacturer or a Customer Care service. The DM Server is a endpoint, generally secured, with which DM Clients communicate. The protocol used between Server and Client is not in the scope of this ontology. It can follow a DM standard such as CWMP or LwM2M, or be completely proprietary.
- Client: Software entity which represents a Device by exposing its DM Functions to one or more DM Server(s). It is responsible for the triggering of the DM Functions when a Command targeting the represented Device is received by the Server. The Client is also responsible for the reporting of the results of the Function execution to the Server. The Client has an identifier that is unique only relatively to each Server it is connected to.
- Device Management Capabilities: these capabilities are represented through categories of saref:Function and saref:Command. These capabilities rely on a set of high-level DM-specific device resources, namely the identity, firmware, packages, and modules. These resources can be manipulated through lower-level representations, namely the Supported Datamodel, and the Datamodel Parameters:
  - Device Management Function Category: Category of saref:Function corresponding to the capabilities of the Device to perform its own diagnostics, maintenance, configuration, monitoring and control.
  - Device Management Command Category: Category of saref:Command associated to Device Management Functions.
- Management Service: A saref:Service that represents functions or functions of interest of the Device Management Function Category. The Management Service for a function only exists when a Management Connection connects a Client and a Server that can expose this function.
- Management Connection: Abstract representation of the connection between a DM Client and a DM Server. It does not necessarily imply that a persistent connection is established between the entities, such as a TCP connection. It represents the link and the capability of the Server to interact with the Client. For instance, the Client has been authenticated by the Server with a certificate, and/or the client has received a configuration for access rights to its functions for the Server.

Table 1: Prefixes and namespaces used within the SAREF4DMGT modular ontology

Prefix	Namespace
dcterms	http://purl.org/dc/terms/
foaf	http://xmlns.com/foaf/0.1/
owl	http://www.w3.org/2002/07/owl#
rdf	http://www.w3.org/1999/02/22-rdf-syntax-ns#
rdfs	http://www.w3.org/2000/01/rdf-schema#
s4dmgt	https://saref.etsi.org/saref4dmgt/
s4syst	https://saref.etsi.org/saref4syst/
saref	https://saref.etsi.org/core/
skos	http://www.w3.org/2004/02/skos/core#
vann	http://purl.org/vocab/vann/
xml	http://www.w3.org/XML/1998/namespace
xsd	http://www.w3.org/2001/XMLSchema#

4.2 SAREF4DMGT

4.2.1 Introduction

As already introduced in Clause 4.1 of the present document, SAREF4DMGT is an OWL-DL ontology that describes the domain of Device Management. To this end, multiple concepts need to be introduced.

First, SAREF4DMGT relies on a set of SAREF-defined concepts, which are saref:Function, saref:Command, and saref:Service.
The Function is specialized to represent DM-specific capabilities, while the Command enables the representation of the exposition of these DM-specific capabilities. Finally, the Service is instantiated with a DM Service, that encompasses the set of functions related to DM.

These base concepts allow the representation of Device Management specific entities, which were extracted from the analysis of the major standards used for Device Management by Telecommunication Operators.
For the purpose of the present document, the following standards were analysed:

- BBF CWMP: The Customer Premises Equipment Wide Area Network Management Protocol, a.k.a. TR-069 [4], was created by the BroadBand Forum to address the Device Management requirement of Telecommunication Operators, with a specialization on gateway fleets management. While the protocol itself is defined in the Technical Report 069, the datamodel of devices is described in the Technical Report 181 [5].

- BBF USP: The User Services Platform [6] is the direct evolution of CWMP at the BroadBand Forum. The core principles are updated to allow a decentralized architecture compared to CWMP, with shared management through Access Control Lists.

- OMA LwM2M: The LightWeight Machine-to-Machine protocol [7] from the Open Mobile Alliance is a standardized protocol for remote device management, telemetry, and secure communication in IoT ecosystems. LwM2M enforces interoperability through standardized capabilities with registries [i.1] promoting the reuse of resources across vendors and manufacturers.

- oneM2M: oneM2M [8] brings together all components in the IoT solution stack. It avoids reinvention in favor of reusing existing technology components and standards. oneM2M's architecture defines a common middleware technology in a horizontal layer between devices and communications networks and IoT applications. This standardizes links between connected devices, gateways, communications networks and cloud infrastructure. For the purpose of the present document, the following specifications were explored: "Management enablement (OMA)" [9], "Management enablement (BBF)" [10], "LwM2M Interworking" [11], and "SDT based Information Model and Mapping for Vertical Industries, section 5.8 Device Management" [12].

The SAREF4DMGT ontology represents the set of physical and software entities involved in Device Management, such as Manageable Device, Client, Server, Connection and Service.

The SAREF4DMGT ontology also models the following specific device capabilities to operate Device Management: Identity, Firmware, Package, Module, Device Control.

Finally, the SAREF4DMGT ontology models the technical representation of these capabilities in the different protocols. These capabilities are exposed as datamodels, hierarchical and technical data structures exposing parameters with their related types and available operations, represented as primitives. Thus, two concepts are introduced: Supported Datamodel, and Datamodel Parameters.

4.2.2 Domain resources

4.2.2.1 General overview

The Device Management domain involves the following entities: Manageable Device, Client, Server, Connection and Service. They are necessary to enable the discovery and control of Management functions remotely for a Device Management Operator.

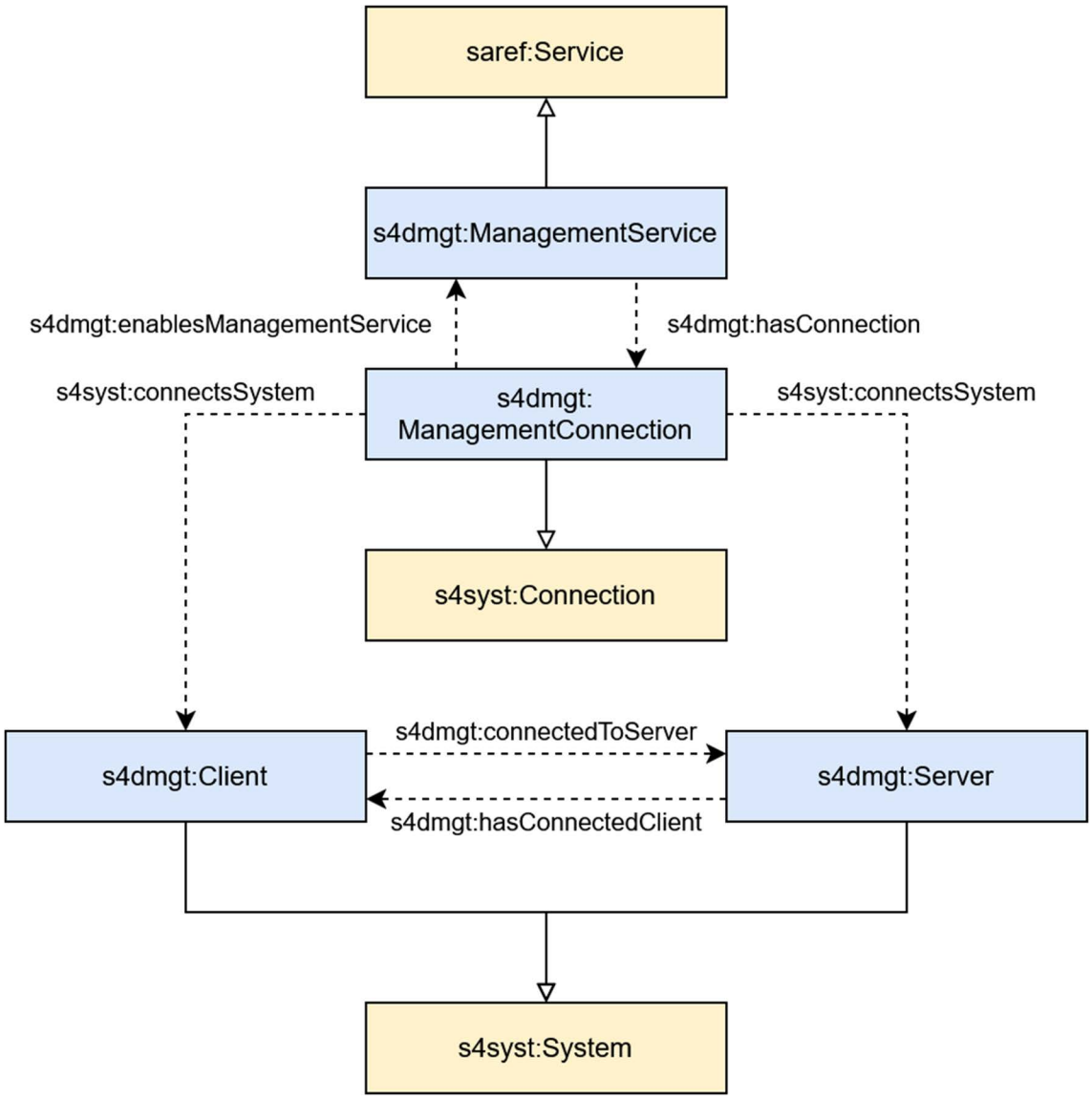

Figure 2: Detailed view of SAREF4DMGT Domain Resources

The architecture of Device Management systems consists in a client/server architecture, where the client is responsible for the local activation of functions, while the server is the remote, secure endpoint that enables the connection with the Information System of the operator. The representation of this connection relies on the SAREF4SYST patterns [2].

Devices are managed as fleets as well as individuals, whether for fleet-wide campaigns such as firmware upgrades, or specific actions, e.g. diagnostics destined to Customer Care.

While this architecture used to be centralized with a single server managing every device of the fleet, for instance with CWMP, newer standard protocols introduce shared management of devices, with multiple actors, servers, and access rights for each resource.

4.2.2.2 Manageable Device

Specialization of saref:Device, the s4dmgt:ManageableDevice is a saref:FeatureOfInterest that consists in a device that supports at least one Device Management function, exposed through a command.

4.2.2.3 Client

The client of a device is a s4syst:System which exposes the DM Functions of this device to one or more DM Servers. The relationship linking a s4dmgt:Client to the s4dmgt:Device is the s4dmgt:representsDevice object property, and its inverse s4dmgt:isRepresentedBy.

A client is responsible for a single device, while a device may be managed through multiple clients.

4.2.2.4 Server

The s4dmgt:Server is a s4syst:System, hosted in the network, which is the secured endpoint with which any s4dmgt:Client communicate. The Server is responsible for performing fleet-wide operations. The Server is the entity that exposes the set of available commands to DM Operators of manufacturers, telecommunication operators, or Customer Care services.

4.2.2.5 Management Connection

The s4dmgt:ManagementConnection is a s4syst:Connection that is the abstract representation of the connection between a s4dmgt:Client and a s4dmgt:Server. The s4dmgt:Connection can also provide metadata on the existing link between client and server, such as specific authentication or encryption schemes shared by these two entities.

These metadata are freely extensible to any implementation requirements. For instance, Connections are not limited to direct Client-to-Server connections, but also include broker-based architectures such as message-oriented middleware.

A s4dmgt:Client may be connected to multiple s4dmgt:Server, with the restriction of a single s4dmgt:ManagementConnection for any pair s4dmgt:Server/s4dmgt:Client.

4.2.2.6 Management Service

A saref:Service that represents functions or functions of interest of the Device Management Function Category.

The s4dmgt:ManagementService exposes these functions through a Connection, between a Client and a Server.

s4dmgt:ManagementService and s4dmgt:ManagementConnection are linked through two object properties, s4dmgt:enablesManagementService and its inverse s4dmgt:hasConnection, which underline the fact that a s4dmgt:ManagementService only exists through its underlying s4dmgt:ManagementConnection.

4.2.3 DM Capabilities

4.2.3.1 General overview

The list of DM capabilities comprises the following entities: Identity, Firmware, Package, Module, Device Control. Each resource is described in detail in this clause.

Following the SAREF pattern [1], capabilities are each modeled as a specific saref:Function which specializes the s4dmgt:DeviceManagementFunctionCategory.

Their related properties are each modeled as an individual of a saref:Property which specializes a single property, e.g. s4dmgt:DeviceIdentityProperty, through a skos:narrower object property.

All Device Management related commands specialize the s4dmgt:DeviceManagementCommandCategory.
In particular, the commands related with a capability are each modeled as a specific saref:Command which specializes their dedicated command category, e.g. s4dmgt:DeviceIdentityCommandCategory.

4.2.3.2 Identity

The s4dmgt:DeviceIdentityFunction corresponds to the capability of a device to expose a set of resources allowing the identification of that specific device among a fleet of devices. This identification can rely on a set of parameters combined to guarantee uniqueness.

A property associated with the s4dmgt:DeviceIdentityFunction function has a relationship skos:narrower with the property s4dmgt:DeviceIdentityProperty.
The list of identified properties comprises the following individuals: s4dmgt:Manufacturer, s4dmgt:HardwareVersion, s4dmgt:ModelName, s4dmgt:ModelNumber, and s4dmgt:SerialNumber.

This list is not exhaustive and is meant to be extended depending on the requirements of the Device Management Operator and their fleet.

The commands associated with the s4dmgt:DeviceIdentityFunction specialize the s4dmgt:DeviceIdentityCommandCategory, and comprise the following individual: s4dmgt:DeviceInfoRetrievalCommand.

4.2.3.3 Firmware

The s4dmgt:FirmwareManagementFunction (see Figure 3) enable the management of the firmware for a device, i.e. the program embedded within that device, loaded and executed at startup, which enables hardware access and control, enabling any device service.

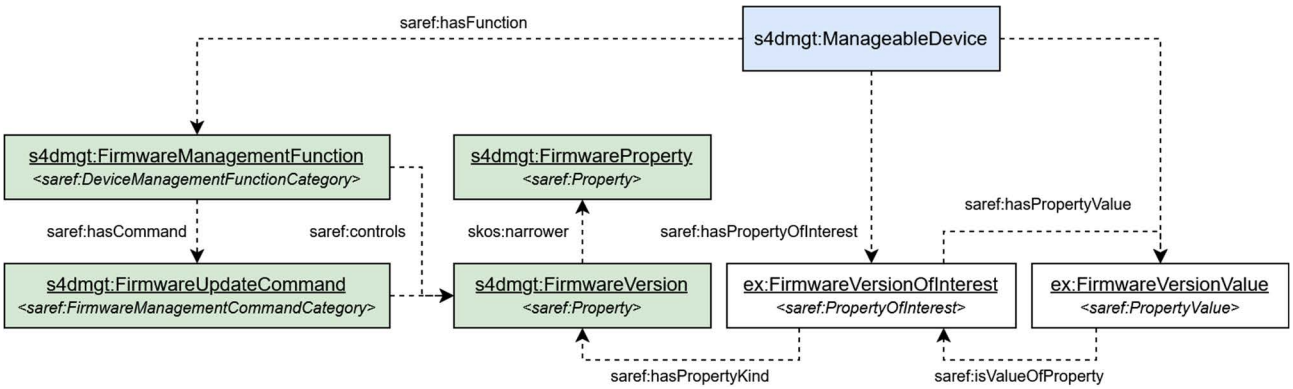

Figure 3: Detailed view of Firmware Management

A property associated with the s4dmgt:FirmwareManagementFunction function has a relationship skos:narrower with the property s4dmgt:FirmwareProperty.
The list of identified properties comprises the following individual: s4dmgt:FirmwareVersion.

The commands associated with the s4dmgt:FirmwareManagementFunction specialize the s4dmgt:FirmwareManagementCommandCategory, and comprise the following individuals: s4dmgt:FirmwareInformationRetrievalCommand, and s4dmgt:FirmwareUpdateCommand.

4.2.3.4 Package

The s4dmgt:PackageManagementFunction (see Figure 4) enables the management of packages for a device. A s4dmgt:DevicePackage is a saref:FeatureOfInterest that represents an archive file that may contain resource files, code, libraries or executable files.

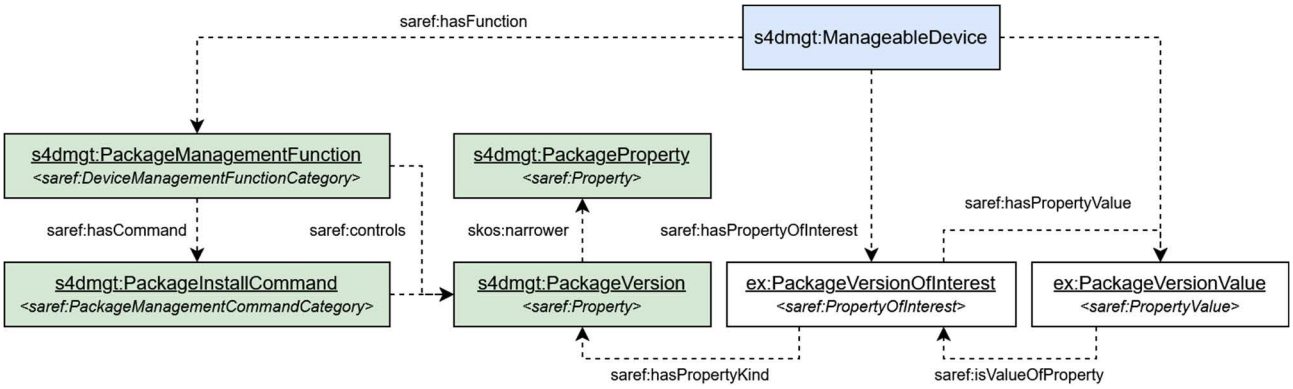

Figure 4: Detailed view of Package Management

This resource follows its own lifecycle (see Figure 5), with the following states that specialize the s4dmgt:DevicePackageState: s4dmgt:DevicePackageInitialized, s4dmgt:DevicePackageDownloading, s4dmgt:DevicePackageDownloaded, s4dmgt:DevicePackageValidated, s4dmgt:DevicePackageInstalling, s4dmgt:DevicePackageInstalled, s4dmgt:DevicePackageUninstalling, s4dmgt:DevicePackageUninstalled.

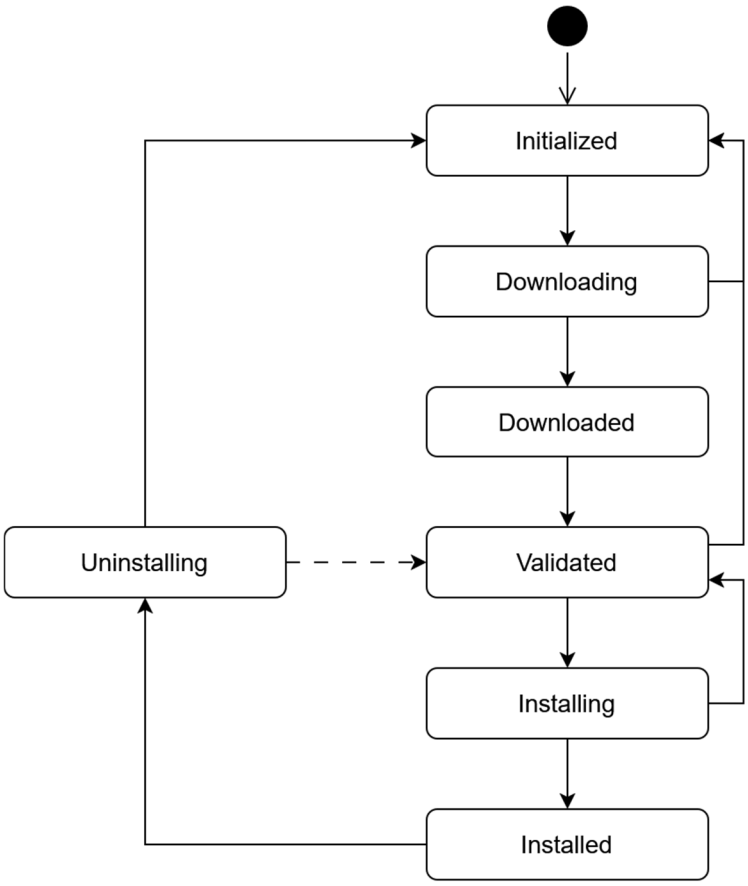

Figure 5: Detailed view of Package state machine

A property associated with the s4dmgt:PackageManagementFunction function has a relationship skos:narrower with the property s4dmgt:PackageProperty.
The list of identified properties comprises the following individual: s4dmgt:PackageName, s4dmgt:PackageVersion.

The commands associated with the s4dmgt:PackageManagementFunction specialize the s4dmgt:PackageManagementCommandCategory, and comprise the following individuals: s4dmgt:PackageInformationRetrievalCommand, s4dmgt:PackageCreationCommand, s4dmgt:PackageDeletionCommand, s4dmgt:PackageDiscoveryCommand, s4dmgt:PackageUpdateCommand, s4dmgt:PackageDownloadCommand, s4dmgt:PackageInstallCommand, s4dmgt:PackageUninstallCommand.

4.2.3.5 Module

The s4dmgt:ModuleManagementFunction (see Figure 6) enables the management of modules for a device. A s4dmgt:DeviceModule is a saref:FeatureOfInterest that represents an executable software entity on the device. The Device Module implements specific Functions that are available to the Device when the Device Module is activated. It may result from a package installation: deleting the corresponding Device Package will in turn remove the Device Module and its related Functions. This dependency is represented through the object properties s4dmgt:enablesDeviceModule, and its inverse s4dmgt:hasDevicePackage.

This resource follows its own lifecycle, with the following states that specialize the s4dmgt:DeviceModuleState: s4dmgt:DeviceModuleActivated, s4dmgt:DeviceModuleDeactivated.

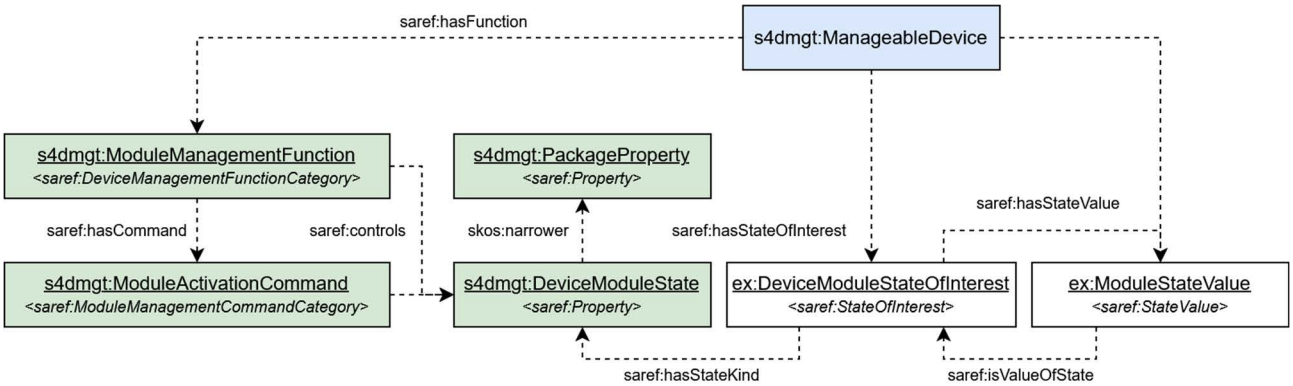

Figure 6: Detailed view of Module Management

A property associated with the s4dmgt:ModuleManagementFunction function has a relationship skos:narrower with the property s4dmgt:ModuleProperty.
The list of identified properties comprises the following individual: s4dmgt:ModuleName, s4dmgt:ModuleVersion.

The commands associated with the s4dmgt:ModuleManagementFunction specialize the s4dmgt:ModuleManagementCommandCategory, and comprise the following individuals: s4dmgt:ModuleInformationRetrievalCommand, s4dmgt:ModuleDiscoveryCommand, s4dmgt:ModuleActivationCommand, s4dmgt:ModuleDeactivationCommand.

4.2.3.6 Device Control

The s4dmgt:DeviceControlFunction enables the control the global state of the device, e.g. its power state through the Reboot function, or the global configuration through the Reset function.

No property is associated to this function.

The commands associated with the s4dmgt:DeviceControlFunction specialize the s4dmgt:DeviceControlCommandCategory, and comprise the following individuals: s4dmgt:RebootCommand, and s4dmgt:ResetCommand. This list is not exhaustive and is meant to be extended depending on the requirements of the Device Management Operator and their fleet.

4.2.4 Datamodels, technical representation of capabilities

4.2.4.1 General overview

The Datamodel is a commonly adopted solution to represent and manipulate device capabilities for Device Management protocols.
For instance, CWMP and USP rely on the Technical Report 181 (TR-181 [5]), while LwM2M specifies its own datamodel, split into objects defined in the LwM2M Registries [i.1].

Datamodels are hierarchical structures composed of parameters, coherently grouped through objects and/or tables.
Two aspects can be defined for a datamodel: the Supported Datamodel, which represents the abstract capabilities of the device, and allows their discovery; and the Datamodel Parameters, which contain the current state of the device, and enables the manipulation of parameters and their values.

Datamodels are the basis for the representation of capabilities during the exchanges between Server and Client. Each of the parameters contained with a datamodel support a set of Primitives, i.e. the basic operations that are available for their manipulation. These primitives will for instance include the basic "Create", "Read", "Update", "Delete" operations and their corresponding names in the different protocols. Other identified primitives are the "Operate" primitive, which exclusively targets parameters representing executable functions; and "Subscribe", enabling automatic notifications, e.g. for value changes of a parameter.

For instance, to retrieve the value for the "Manufacturer" property of the Device Identity, the parameter path will be defined hierarchically for both USP and LwM2M. For USP, it is retrieved through a "Get" Request targeting the path "Device.DeviceInfo.Manufacturer", to retrieve a string with a maximum length of 64. In that case, "Device" is the root object containing the whole datamodel, "DeviceInfo" is an object containing the parameters related to the Device Identity, and "Manufacturer" is a string-valued parameter within this "DeviceInfo" object.
For LwM2M, this value is retrieved through a "Get" Request targeting the path "/3/0/0". "/" is the root of the datamodel, "/3" represents the "Device" object, "/3/0" represents the first and unique instance of the "Device" object, and "/3/0/0" represents the first parameter, whose name is "Manufacturer".

The Ontology defines both the s4dmgt:SupportedDatamodelFunction and the s4dmgt:DatamodelParameterFunction to represent this low-level manipulation of resources.

4.2.4.2 Supported datamodel

The s4dmgt:SupportedDatamodelFunction (see Figure 7) enables the manipulation of the supported datamodel of a Device. This represents the supported capabilities of that device, i.e. the available parameters and operations on these parameters.

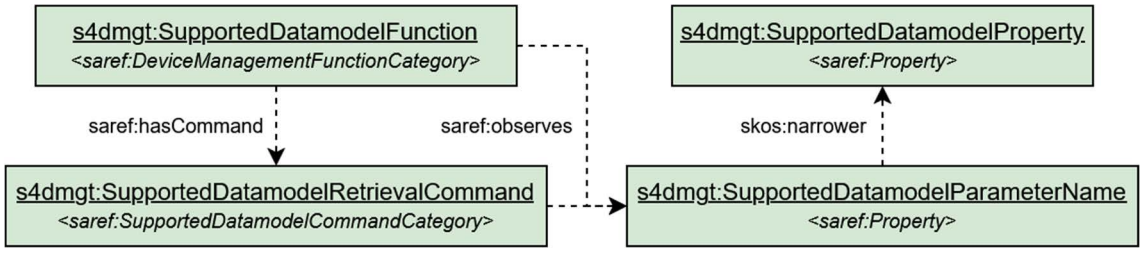

Figure 7: Detailed view of Supported Datamodel resources

A property associated with the s4dmgt:SupportedDatamodelFunction function has a relationship skos:narrower with the property s4dmgt:SupportedDatamodelParameterProperty.
The list of identified properties comprises the following individual: s4dmgt:SupportedDatamodelParameterName, s4dmgt:SupportedDatamodelParameterType, and s4dmgt:SupportedDatamodelParameterPrimitives.

The commands associated with the s4dmgt:SupportedDatamodelFunction specialize the s4dmgt:SupportedDatamodelCommandCategory, and comprise the following individuals: s4dmgt:SupportedDatamodelRetrievalCommand.

4.2.4.3 Datamodel parameters

The s4dmgt:DatamodelParameterFunction (see Figure 8) enables the manipulation of the datamodel parameter instances of a Device. The datamodel parameter instances represent the current state of each device capability and their configurations.

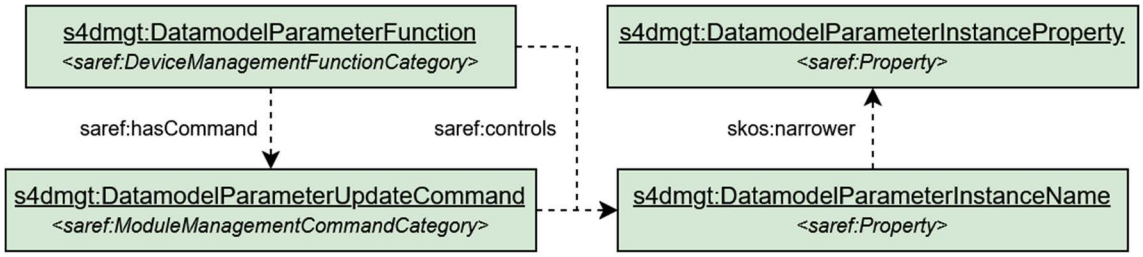

Figure 8: Detailed view of Datamodel Parameters resources

A property associated with the s4dmgt:DatamodelParameterFunction function has a relationship skos:narrower with the property s4dmgt:DatamodelParameterInstanceProperty.
The list of identified properties comprises the following individual: s4dmgt:DatamodelParameterInstanceName, s4dmgt:DatamodelParameterInstanceValue.

The commands associated with the s4dmgt:DatamodelParameterFunction specialize the s4dmgt:DatamodelParameterCommandCategory, and comprise the following individuals: s4dmgt:DatamodelParameterCreationCommand, s4dmgt:DatamodelParameterDeletionCommand, s4dmgt:DatamodelParameterRetrievalCommand, s4dmgt:DatamodelParameterUpdateCommand, s4dmgt:DatamodelParameterOperateCommand.

Annex A (informative): Bibliography

- Aïssaoui, F., Berlemont, S., Douet, M., Mezghani, E. (2020): "A Semantic Model Toward Smart IoT Device Management". In: Barolli, L., Amato, F., Moscato, F., Enokido, T., Takizawa, M. (eds) Web, Artificial Intelligence and Network Applications. WAINA 2020. Advances in Intelligent Systems and Computing, vol 1150. Springer, Cham.

Annex B (normative): Ontology Reference

B.1 Classes

s4dmgt:Client — Client

IRI: https://saref.etsi.org/saref4dmgt/Client
is a: owl:Class
definition: Software entity which represents a Device by exposing its DM Functions to one or more DM Server(s).

It is responsible for the triggering of the DM Functions when a Command targeting the represented Device is received by the Server. The Client is also responsible for the reporting of the results of the Function execution to the Server.

The Client has an identifier that is unique only relatively to each Server it is connected to.
super-classes: s4syst:System
is in domain of: s4dmgt:connectedToServer
s4dmgt:representsDevice
is in range of: s4dmgt:hasConnectedClient
s4dmgt:isRepresentedBy

s4dmgt:DatamodelParameterCommandCategory — Datamodel Parameter Command Category

IRI: https://saref.etsi.org/saref4dmgt/DatamodelParameterCommandCategory
is a: owl:Class
definition: Category of commands enabling the manipulation of one or more Datamodel Parameters.
super-classes: s4dmgt:DeviceManagementCommandCategory
members: s4dmgt:DatamodelParameterCreationCommand, s4dmgt:DatamodelParameterDeletionCommand, s4dmgt:DatamodelParameterOperateCommand, s4dmgt:DatamodelParameterRetrievalCommand, s4dmgt:DatamodelParameterUpdateCommand

s4dmgt:DeviceControlCommandCategory — Device Control Command Category

IRI: https://saref.etsi.org/saref4dmgt/DeviceControlCommandCategory
is a: owl:Class
definition: Category of commands enabling the manipulation of the device state, for instance the power state with a Reboot or Shutdown command.
super-classes: s4dmgt:DeviceManagementCommandCategory
members: s4dmgt:RebootCommand, s4dmgt:ResetCommand

s4dmgt:DeviceIdentityCommandCategory — Device Identity Command Category

IRI: https://saref.etsi.org/saref4dmgt/DeviceIdentityCommandCategory
is a: owl:Class
definition: Category of commands enabling the manipulation of device identification properties.
super-classes: s4dmgt:DeviceManagementCommandCategory
members: s4dmgt:DeviceInfoRetrievalCommand

s4dmgt:DeviceManagementCommandCategory — Device Management Command Category

IRI: https://saref.etsi.org/saref4dmgt/DeviceManagementCommandCategory
is a: owl:Class
definition: Category of Commands that are specific to the Device Management domain.
super-classes: saref:Command
sub-classes: s4dmgt:DatamodelParameterCommandCategory
s4dmgt:DeviceControlCommandCategory
s4dmgt:DeviceIdentityCommandCategory
s4dmgt:FirmwareManagementCommandCategory
s4dmgt:ModuleManagementCommandCategory
s4dmgt:PackageManagementCommandCategory
s4dmgt:SupportedDatamodelCommandCategory

s4dmgt:DeviceManagementFunctionCategory — Device Management Function Category

IRI: https://saref.etsi.org/saref4dmgt/DeviceManagementFunctionCategory
is a: owl:Class
definition: Category of Functions related to the Device Management domain.

These Functions correspond to the capabilities of the Device to perform its own diagnostics, maintenance, configuration, monitoring and control.
super-classes: saref:Function
members: s4dmgt:DatamodelParameterFunction, s4dmgt:DeviceControlFunction, s4dmgt:DeviceIdentityFunction, s4dmgt:FirmwareManagementFunction, s4dmgt:ModuleManagementFunction, s4dmgt:PackageManagementFunction, s4dmgt:SupportedDatamodelFunction

s4dmgt:DeviceManagementState — Device Management State

IRI: https://saref.etsi.org/saref4dmgt/DeviceManagementState
is a: owl:Class
definition: This is a class of states for Device Management.
super-classes: saref:State
sub-classes: s4dmgt:DeviceModuleState
s4dmgt:DevicePackageState

s4dmgt:DeviceModule — Device Module

IRI: https://saref.etsi.org/saref4dmgt/DeviceModule
is a: owl:Class
definition: A DeviceModule is an executable software entity on the Device, i.e. a DeviceModule may be activated and deactivated on demand through dedicated Functions.

As such, the DeviceModule implements specific Functions that are available to the Device when the DeviceModule is activated.

A DeviceModule may be supported by a DevicePackage: deleting the corresponding DevicePackage will in turn remove the DeviceModule and its related Functions.
super-classes: saref:FeatureOfInterest

s4dmgt:DeviceModuleState — Device Module State

IRI: https://saref.etsi.org/saref4dmgt/DeviceModuleState
is a: owl:Class
definition: State of a DeviceModule
super-classes: s4dmgt:DeviceManagementState

is disjoint with: s4dmgt:DevicePackageState
members: s4dmgt:DeviceModuleActivated, s4dmgt:DeviceModuleDeactivated

s4dmgt:DevicePackage — Device Package

IRI: https://saref.etsi.org/saref4dmgt/DevicePackage
is a: owl:Class
definition: A DevicePackage is an archive file that may contain resource files, code, libraries or executable files.
It is a resource that the Device should retrieve or receive from an external source.

A DevicePackage is only actionable once it has been downloaded and installed.

It may allow a Device to support additional Functions by instantiating a DeviceModule.

A DevicePackage may be uninstalled and then removed from the Device.
super-classes: saref:FeatureOfInterest

s4dmgt:DevicePackageState — Device Package State

IRI: https://saref.etsi.org/saref4dmgt/DevicePackageState
is a: owl:Class
definition: State of a DevicePackage
super-classes: s4dmgt:DeviceManagementState
is disjoint with: s4dmgt:DeviceModuleState
members: s4dmgt:DevicePackageDownloaded, s4dmgt:DevicePackageDownloading, s4dmgt:DevicePackageInitialized, s4dmgt:DevicePackageInstalled, s4dmgt:DevicePackageInstalling, s4dmgt:DevicePackageUninstalling, s4dmgt:DevicePackageValidated

s4dmgt:FirmwareManagementCommandCategory — Firmware Management Command Category

IRI: https://saref.etsi.org/saref4dmgt/FirmwareManagementCommandCategory
is a: owl:Class
definition: Category of commands enabling the manipulation of device firmwares.
super-classes: s4dmgt:DeviceManagementCommandCategory
members: s4dmgt:FirmwareInformationRetrievalCommand, s4dmgt:FirmwareUpdateCommand

s4dmgt:ManageableDevice — Manageable Device

IRI: https://saref.etsi.org/saref4dmgt/ManageableDevice
is a: owl:Class
definition: A tangible object that has at least one Device Management Function.

This class extends the saref:Device class, it is a Feature of Interest by definition.
super-classes: saref:Device
is in domain of: s4dmgt:isRepresentedBy
is in range of: s4dmgt:representsDevice

s4dmgt:ManagementConnection — Management Connection

IRI: https://saref.etsi.org/saref4dmgt/ManagementConnection
is a: owl:Class
definition: Abstract representation of the connection between a Client and a Server. It does not necessarily imply that a persistent connection is established between the entities - such as a TCP connection. It represents the link and the capability of the Server to interact with the Client.

For instance, the Client has been authenticated by the Server with a certificate, and/or the client has received a configuration for access rights to its functions for the Server.

super-classes: s4syst:Connection **and** (s4syst:connectsSystem **some** s4dmgt:Client) **and** (s4syst:connectsSystem **some** s4dmgt:Server)
is in domain of: s4dmgt:enablesManagementService
is in range of: s4dmgt:hasConnection

s4dmgt:ManagementService — Management Service

IRI: https://saref.etsi.org/saref4dmgt/ManagementService
is a: owl:Class
definition: A saref:Service that represents functions or functions of interest of the Device Management Function Category.

The ManagementService exposes these functions through a Connection, between a Client and a Server.
super-classes: saref:Service
is in domain of: s4dmgt:hasConnection
is in range of: s4dmgt:enablesManagementService

s4dmgt:ModuleManagementCommandCategory — Module Management Command Category

IRI: https://saref.etsi.org/saref4dmgt/ModuleManagementCommandCategory
is a: owl:Class
definition: Category of commands enabling the manipulation of device modules.
super-classes: s4dmgt:DeviceManagementCommandCategory
members: s4dmgt:ModuleActivationCommand, s4dmgt:ModuleDeactivationCommand, s4dmgt:ModuleDiscoveryCommand, s4dmgt:ModuleInformationRetrievalCommand

s4dmgt:PackageManagementCommandCategory — Package Management Command Category

IRI: https://saref.etsi.org/saref4dmgt/PackageManagementCommandCategory
is a: owl:Class
definition: Category of commands enabling the manipulation of device packages.
super-classes: s4dmgt:DeviceManagementCommandCategory
members: s4dmgt:PackageCreationCommand, s4dmgt:PackageDeletionCommand, s4dmgt:PackageDiscoveryCommand, s4dmgt:PackageDownloadCommand, s4dmgt:PackageInformationRetrievalCommand, s4dmgt:PackageInstallCommand, s4dmgt:PackageUninstallCommand, s4dmgt:PackageUpdateCommand

s4dmgt:Server — Server

IRI: https://saref.etsi.org/saref4dmgt/Server
is a: owl:Class
definition: A DM Server is the software entity which is responsible for performing DM operations on a fleet of Devices. It exposes the set of available operations to an entity that needs to trigger an operation, such as a manufacturer or a Customer Care service.

The DM Server is a endpoint, generally secured, with which DM Clients communicate.

The protocol used between Server and Client is not in the scope of this ontology. It can follow a DM standard such as CWMP or LwM2M, or be completely proprietary.
super-classes: s4syst:System
is in domain of: s4dmgt:hasConnectedClient
is in range of: s4dmgt:connectedToServer

s4dmgt:SupportedDatamodelCommandCategory — Supported Datamodel Command Category

IRI: https://saref.etsi.org/saref4dmgt/SupportedDatamodelCommandCategory
is a: owl:Class
definition: Category of commands enabling the manipulation of supported datamodels.
super-classes: s4dmgt:DeviceManagementCommandCategory
members: s4dmgt:SupportedDatamodelRetrievalCommand

B.2 Object Properties

s4dmgt:connectedToServer — connected to server

IRI: https://saref.etsi.org/saref4dmgt/connectedToServer
is a: owl:ObjectProperty
definition: Relationship between a Client and a Server when the Client is connected and authenticated to a Server, enabling the exposition of its DM Functions. This relationship could be inferred when a Management Service connects both the Client and the Server. Inverse of saref4dmgt:hasConnectedClient.
super-properties: s4syst:connectedTo
domain: s4dmgt:Client
range: s4dmgt:Server
is inverse of: s4dmgt:hasConnectedClient

s4dmgt:enablesDeviceModule — enables device module

IRI: https://saref.etsi.org/saref4dmgt/enablesDeviceModule
is a: owl:ObjectProperty
definition: A relationship between a DevicePackage and a DeviceModule that represents the fact that the DeviceModule only exists thanks to the DevicePackage. If the DevicePackage is uninstalled, the DeviceModule does not exist anymore.
is inverse of: s4dmgt:hasDevicePackage

s4dmgt:enablesManagementService — enables management service

IRI: https://saref.etsi.org/saref4dmgt/enablesManagementService
is a: owl:ObjectProperty
definition: A relationship between a Management Service and Management Connection that represents the fact that a Management Service only exists thanks to the Management Connection. If the Management Connection is closed, the Management Service does not exist anymore.
domain: s4dmgt:ManagementConnection
range: s4dmgt:ManagementService
is inverse of: s4dmgt:hasConnection

s4dmgt:hasConnectedClient — has connected client

IRI: https://saref.etsi.org/saref4dmgt/hasConnectedClient
is a: owl:ObjectProperty
definition: Relationship between a Server and a Client when the Client is connected and authenticated to the Server, enabling the exposition of its DM Functions. This relationship could be inferred when a Management Service connects both the Client and the Server. Inverse of saref4dmgt:connectedToServer.
super-properties: s4syst:connectedTo
domain: s4dmgt:Server
range: s4dmgt:Client
is inverse of: s4dmgt:connectedToServer

s4dmgt:hasConnection — has connection

IRI: https://saref.etsi.org/saref4dmgt/hasConnection
is a: owl:ObjectProperty
definition: A relationship between a Management Service and a Management Connection, indicating that the Management Service exists solely because of the Management Connection. If the Management Connection ceases to exist, the Management Service will also cease to exist..
domain: s4dmgt:ManagementService
range: s4dmgt:ManagementConnection
is inverse of: s4dmgt:enablesManagementService

s4dmgt:hasDevicePackage — has device package

IRI: https://saref.etsi.org/saref4dmgt/hasDevicePackage
is a: owl:ObjectProperty
definition: A relationship between a DeviceModule and a DevicePackage that represents the fact that the DeviceModule only exists thanks to the DevicePackage. If the DevicePackage is uninstalled, the DeviceModule does not exist anymore.
is inverse of: s4dmgt:enablesDeviceModule

s4dmgt:isRepresentedBy — is represented by

IRI: https://saref.etsi.org/saref4dmgt/isRepresentedBy
is a: owl:ObjectProperty
definition: A relationship between a Manageable Device and one of the Clients that expose its DM functions to DM servers.
domain: s4dmgt:ManageableDevice
range: s4dmgt:Client
is inverse of: s4dmgt:representsDevice

s4dmgt:representsDevice — represents device

IRI: https://saref.etsi.org/saref4dmgt/representsDevice
is a: owl:ObjectProperty
definition: A relationship between a Client and the Device whose DM functions the Client exposes to DM servers.
domain: s4dmgt:Client
range: s4dmgt:ManageableDevice
is inverse of: s4dmgt:isRepresentedBy

B.3 Named Individuals

s4dmgt:DatamodelParameterCreationCommand — Datamodel parameter creation command

IRI: https://saref.etsi.org/saref4dmgt/DatamodelParameterCreationCommand
is a: owl:Thing
definition: Command to create a datamodel parameter instance.
belongs to: s4dmgt:DatamodelParameterCommandCategory
saref:controls: s4dmgt:DatamodelParameterInstanceProperty

s4dmgt:DatamodelParameterDeletionCommand — Datamodel parameter deletion command

IRI: https://saref.etsi.org/saref4dmgt/DatamodelParameterDeletionCommand
is a: owl:Thing
definition: Command to delete a datamodel parameter instance.

belongs to: s4dmgt:DatamodelParameterCommandCategory
saref:controls: s4dmgt:DatamodelParameterInstanceProperty

s4dmgt:DatamodelParameterFunction — Datamodel parameter function

IRI: https://saref.etsi.org/saref4dmgt/DatamodelParameterFunction
is a: owl:Thing
definition: Function kind for the manipulation of datamodel parameters.
belongs to: s4dmgt:DeviceManagementFunctionCategory
saref:hasCommand: s4dmgt:DatamodelParameterCreationCommand, s4dmgt:DatamodelParameterDeletionCommand, s4dmgt:DatamodelParameterOperateCommand, s4dmgt:DatamodelParameterRetrievalCommand, s4dmgt:DatamodelParameterUpdateCommand

s4dmgt:DatamodelParameterInstanceName — Datamodel parameter instance name

IRI: https://saref.etsi.org/saref4dmgt/DatamodelParameterInstanceName
is a: owl:Thing
definition: Name for an instance of a datamodel parameter.
belongs to: saref:Property
skos:narrower: s4dmgt:DatamodelParameterInstanceProperty

s4dmgt:DatamodelParameterInstanceProperty — Datamodel parameter instance property

IRI: https://saref.etsi.org/saref4dmgt/DatamodelParameterInstanceProperty
is a: owl:Thing
definition: Property kind that represents the properties of a Datamodel Parameter Instance.

These parameter instances represent the actionable capabilities of the Device in a format specific to the datamodel implemented by the Device, and exposed by the Client.

It should not be confused with the Supported Datamodel Parameter, which represents the abstract capabilities of the Device.
belongs to: saref:Property
skos:broader: s4dmgt:DatamodelParameterInstanceName, s4dmgt:DatamodelParameterInstanceValue

s4dmgt:DatamodelParameterInstanceValue — Datamodel parameter instance value

IRI: https://saref.etsi.org/saref4dmgt/DatamodelParameterInstanceValue
is a: owl:Thing
definition: Value of a datamodel parameter instance, obtained as the result of the execution of a Datamodel parameter retrieval command.
belongs to: saref:Property
skos:narrower: s4dmgt:DatamodelParameterInstanceProperty

s4dmgt:DatamodelParameterOperateCommand — Datamodel parameter operate command

IRI: https://saref.etsi.org/saref4dmgt/DatamodelParameterOperateCommand
is a: owl:Thing
definition: Command to trigger the execution of a datamodel parameter instance that corresponds to an executable process on a device.
belongs to: s4dmgt:DatamodelParameterCommandCategory
saref:controls: s4dmgt:DatamodelParameterInstanceProperty

s4dmgt:DatamodelParameterRetrievalCommand — Datamodel parameter retrieval command

IRI: https://saref.etsi.org/saref4dmgt/DatamodelParameterRetrievalCommand
is a: owl:Thing
definition: Command to retrieve the value of a Datamodel parameter instance.
belongs to: s4dmgt:DatamodelParameterCommandCategory
saref:observes: s4dmgt:DatamodelParameterInstanceProperty

s4dmgt:DatamodelParameterUpdateCommand — Datamodel parameter update command

IRI: https://saref.etsi.org/saref4dmgt/DatamodelParameterUpdateCommand
is a: owl:Thing
definition: Command to update the value of a Datamodel parameter instance.
belongs to: s4dmgt:DatamodelParameterCommandCategory
saref:controls: s4dmgt:DatamodelParameterInstanceProperty

s4dmgt:DeviceControlFunction — Device control function

IRI: https://saref.etsi.org/saref4dmgt/DeviceControlFunction
is a: owl:Thing
definition: Function kind to control the global state of the device, e.g. its power state through the Reboot function, or the global configuration through the Reset function.
belongs to: s4dmgt:DeviceManagementFunctionCategory
saref:hasCommand: s4dmgt:RebootCommand, s4dmgt:ResetCommand

s4dmgt:DeviceIdentityFunction — Device identity function

IRI: https://saref.etsi.org/saref4dmgt/DeviceIdentityFunction
is a: owl:Thing
definition: Function kind that represents the capabilities of a device to expose its own identity.
belongs to: s4dmgt:DeviceManagementFunctionCategory
saref:hasCommand: s4dmgt:DeviceInfoRetrievalCommand

s4dmgt:DeviceIdentityProperty — Device identity property

IRI: https://saref.etsi.org/saref4dmgt/DeviceIdentityProperty
is a: owl:Thing
definition: Set of properties that constitutes a Device Identity.
belongs to: saref:Property
skos:broader: s4dmgt:HardwareVersion, s4dmgt:Manufacturer, s4dmgt:ModelName, s4dmgt:ModelNumber, s4dmgt:SerialNumber

s4dmgt:DeviceInfoRetrievalCommand — Device info retrieval command

IRI: https://saref.etsi.org/saref4dmgt/DeviceInfoRetrievalCommand
is a: owl:Thing
definition: A command to retrieve any Device identity property.
belongs to: s4dmgt:DeviceIdentityCommandCategory
saref:observes: s4dmgt:DeviceIdentityProperty

s4dmgt:DeviceModuleActivated — Device module activated

IRI: https://saref.etsi.org/saref4dmgt/DeviceModuleActivated
is a: owl:Thing

definition: State of a Device Module whose related functions were made available on a device, either automatically after the Device Module installation, or through a Module activation command.
belongs to: s4dmgt:DeviceModuleState

s4dmgt:DeviceModuleDeactivated — Device module deactivated

IRI: https://saref.etsi.org/saref4dmgt/DeviceModuleDeactivated
is a: owl:Thing
definition: State of a Device Module whose related functions were made unavailable through a Module Deactivation Command.
belongs to: s4dmgt:DeviceModuleState

s4dmgt:DevicePackageDownloaded — Device package downloaded

IRI: https://saref.etsi.org/saref4dmgt/DevicePackageDownloaded
is a: owl:Thing
definition: State of a Device Package whose set of required files are available of on the device, either through a download process from a Client, or an upload process from a Server. This is a transitory state, that changes to the either the Device Package Validated state, or returns to the Device Package Initialized state in case of error.
belongs to: s4dmgt:DevicePackageState

s4dmgt:DevicePackageDownloading — Device package downloading

IRI: https://saref.etsi.org/saref4dmgt/DevicePackageDownloading
is a: owl:Thing
definition: State of a Device Package that represents that the process of transferring the required package files is in progress. This state is attained through the Device Package Initialized state either automatically, or through the execution of a Package Download Command. This is a transitory state, that changes to either the Device Package Downloaded or returns to the Device Package Initialized state in case of error.
belongs to: s4dmgt:DevicePackageState

s4dmgt:DevicePackageInitialized — Device package initialized

IRI: https://saref.etsi.org/saref4dmgt/DevicePackageInitialized
is a: owl:Thing
definition: State of a Device Package that represents that the process of creating the required package on the device. This state is attained through the execution of the Package Creation Command. This may be a transitory state, that changes to the Device Package Downloading state automatically.
belongs to: s4dmgt:DevicePackageState

s4dmgt:DevicePackageInstalled — Device package installed

IRI: https://saref.etsi.org/saref4dmgt/DevicePackageInstalled
is a: owl:Thing
definition: State of a Device package whose resources have been made ready for their final purpose, after the download and install processes are completed.
belongs to: s4dmgt:DevicePackageState

s4dmgt:DevicePackageInstalling — Device package installing

IRI: https://saref.etsi.org/saref4dmgt/DevicePackageInstalling
is a: owl:Thing

definition: State of a Device Package that represents that the process of readying the required package files is in progress. This state is attained through the execution of the Package Install Command, from the Device Package Validated state. This is a transitory state, that changes to the Device Package Installed state, or returns to the Device Package Validated state in case of error.
belongs to: s4dmgt:DevicePackageState

s4dmgt:DevicePackageUninstalling — Device package uninstalling

IRI: https://saref.etsi.org/saref4dmgt/DevicePackageUninstalling
is a: owl:Thing
definition: State of a Device Package that represents that the process of removing the associated package files is in progress. This is a transitory state, that either changes to the Device Package Initialized or Device Package Validated states depending on implementation.
belongs to: s4dmgt:DevicePackageState

s4dmgt:DevicePackageValidated — Device package validated

IRI: https://saref.etsi.org/saref4dmgt/DevicePackageValidated
is a: owl:Thing
definition: State of a Device Package that represents that the required package files are available on the device, and actually correspond to the expected files, without corruption. The transition from the Device Package Downloaded state is automatic, and depends on the client and package implementations.
belongs to: s4dmgt:DevicePackageState

s4dmgt:FirmwareInformationRetrievalCommand — Firmware information retrieval command

IRI: https://saref.etsi.org/saref4dmgt/FirmwareInformationRetrievalCommand
is a: owl:Thing
definition: Command to retrieve firmware information such as the current firmware version for a device.
belongs to: s4dmgt:FirmwareManagementCommandCategory
saref:observes: s4dmgt:FirmwareProperty

s4dmgt:FirmwareManagementFunction — Firmware management function

IRI: https://saref.etsi.org/saref4dmgt/FirmwareManagementFunction
is a: owl:Thing
definition: Set of functions related to the management of the firmware for a device.
belongs to: s4dmgt:DeviceManagementFunctionCategory
saref:hasCommand: s4dmgt:FirmwareInformationRetrievalCommand, s4dmgt:FirmwareUpdateCommand

s4dmgt:FirmwareProperty — Firmware property

IRI: https://saref.etsi.org/saref4dmgt/FirmwareProperty
is a: owl:Thing
definition: Property kind that represents the properties of the firmware of a device.

The device firmware is the running base software for a device, which is automatically loaded into memory and executed at boot.
belongs to: saref:Property
skos:broader: s4dmgt:FirmwareVersion

s4dmgt:FirmwareUpdateCommand — Firmware update command

IRI: https://saref.etsi.org/saref4dmgt/FirmwareUpdateCommand
is a: owl:Thing
definition: Command to trigger the update of the firmware of a device.

belongs to: s4dmgt:FirmwareManagementCommandCategory
saref:controls: s4dmgt:FirmwareProperty

s4dmgt:FirmwareVersion — Firmware version

IRI: https://saref.etsi.org/saref4dmgt/FirmwareVersion
is a: owl:Thing
definition: The firmware version of a device.
belongs to: saref:Property
skos:narrower: s4dmgt:FirmwareProperty

s4dmgt:HardwareVersion — Hardware version

IRI: https://saref.etsi.org/saref4dmgt/HardwareVersion
is a: owl:Thing
definition: Device identity property referring to the specific version of the set of physical components of a device, known as hardware version.
belongs to: saref:Property
skos:narrower: s4dmgt:DeviceIdentityProperty

s4dmgt:Manufacturer — Manufacturer

IRI: https://saref.etsi.org/saref4dmgt/Manufacturer
is a: owl:Thing
definition: Device identity property representing the manufacturer of the device.
belongs to: saref:Property
skos:narrower: s4dmgt:DeviceIdentityProperty

s4dmgt:ModelName — Model name

IRI: https://saref.etsi.org/saref4dmgt/ModelName
is a: owl:Thing
definition: Device identity property that represents the device model, i.e. the denomination for a specific hardware design for this device, in a human-readable format.
belongs to: saref:Property
skos:narrower: s4dmgt:DeviceIdentityProperty

s4dmgt:ModelNumber — Model number

IRI: https://saref.etsi.org/saref4dmgt/ModelNumber
is a: owl:Thing
definition: The unique identifier assigned to a device model, used to distinguish it from other models and versions within a manufacturer's product lineup.
belongs to: saref:Property
skos:narrower: s4dmgt:DeviceIdentityProperty

s4dmgt:ModuleActivationCommand — Module activation command

IRI: https://saref.etsi.org/saref4dmgt/ModuleActivationCommand
is a: owl:Thing
definition: Command to trigger the activation of a Device Module.
belongs to: s4dmgt:ModuleManagementCommandCategory

s4dmgt:ModuleDeactivationCommand — Module deactivation command

IRI: https://saref.etsi.org/saref4dmgt/ModuleDeactivationCommand
is a: owl:Thing
definition: Command to trigger the deactivation of a Device Module.
belongs to: s4dmgt:ModuleManagementCommandCategory

s4dmgt:ModuleDiscoveryCommand — Module discovery command

IRI: https://saref.etsi.org/saref4dmgt/ModuleDiscoveryCommand
is a: owl:Thing
definition: Command to retrieve the list of Device Modules available on a device.
belongs to: s4dmgt:ModuleManagementCommandCategory
saref:observes: s4dmgt:ModuleProperty

s4dmgt:ModuleInformationRetrievalCommand — Module information retrieval command

IRI: https://saref.etsi.org/saref4dmgt/ModuleInformationRetrievalCommand
is a: owl:Thing
definition: Command to retrieve device module information such as the name of the module or its version.
belongs to: s4dmgt:ModuleManagementCommandCategory
saref:observes: s4dmgt:ModuleProperty

s4dmgt:ModuleManagementFunction — Module management function

IRI: https://saref.etsi.org/saref4dmgt/ModuleManagementFunction
is a: owl:Thing
definition: Function kind for the management of Device Modules.
belongs to: s4dmgt:DeviceManagementFunctionCategory
saref:hasCommand: s4dmgt:ModuleActivationCommand, s4dmgt:ModuleDeactivationCommand, s4dmgt:ModuleDiscoveryCommand, s4dmgt:ModuleInformationRetrievalCommand

s4dmgt:ModuleName — Module name

IRI: https://saref.etsi.org/saref4dmgt/ModuleName
is a: owl:Thing
definition: The name of a device module.
belongs to: saref:Property
skos:narrower: s4dmgt:ModuleProperty

s4dmgt:ModuleProperty — Module property

IRI: https://saref.etsi.org/saref4dmgt/ModuleProperty
is a: owl:Thing
definition: Property kind that represents the properties of a Device Module.
belongs to: saref:Property
skos:broader: s4dmgt:ModuleName, s4dmgt:ModuleVersion

s4dmgt:ModuleVersion — Module version

IRI: https://saref.etsi.org/saref4dmgt/ModuleVersion
is a: owl:Thing
definition: The version of a Device Module.
belongs to: saref:Property
skos:narrower: s4dmgt:ModuleProperty

s4dmgt:PackageCreationCommand — Package creation command

IRI: https://saref.etsi.org/saref4dmgt/PackageCreationCommand
is a: owl:Thing
definition: Command to trigger the creation of a Device Package on a device.
belongs to: s4dmgt:PackageManagementCommandCategory
saref:controls: s4dmgt:PackageProperty

s4dmgt:PackageDeletionCommand — Package deletion command

IRI: https://saref.etsi.org/saref4dmgt/PackageDeletionCommand
is a: owl:Thing
definition: Command to trigger the deletion of a Device Package on a device.
belongs to: s4dmgt:PackageManagementCommandCategory
saref:controls: s4dmgt:PackageProperty

s4dmgt:PackageDiscoveryCommand — Package discovery command

IRI: https://saref.etsi.org/saref4dmgt/PackageDiscoveryCommand
is a: owl:Thing
definition: Command to retrieve the list of available Device Packages on a device.
belongs to: s4dmgt:PackageManagementCommandCategory
saref:observes: s4dmgt:PackageProperty

s4dmgt:PackageDownloadCommand — Package download command

IRI: https://saref.etsi.org/saref4dmgt/PackageDownloadCommand
is a: owl:Thing
definition: Command to trigger the download of a Device Package in the Device Package Initialized state.
belongs to: s4dmgt:PackageManagementCommandCategory
saref:controls: s4dmgt:PackageProperty

s4dmgt:PackageInformationRetrievalCommand — Package information retrieval command

IRI: https://saref.etsi.org/saref4dmgt/PackageInformationRetrievalCommand
is a: owl:Thing
definition: Command to retrieve device package information such as the name of the package or its version.
belongs to: s4dmgt:PackageManagementCommandCategory
saref:observes: s4dmgt:PackageProperty

s4dmgt:PackageInstallCommand — Package install command

IRI: https://saref.etsi.org/saref4dmgt/PackageInstallCommand
is a: owl:Thing
definition: Command to trigger the installation of Device Package on a device.
belongs to: s4dmgt:PackageManagementCommandCategory
saref:controls: s4dmgt:PackageProperty

s4dmgt:PackageManagementFunction — Package management function

IRI: https://saref.etsi.org/saref4dmgt/PackageManagementFunction
is a: owl:Thing
definition: Function kind related to the management of Device Packages on a device.
belongs to: s4dmgt:DeviceManagementFunctionCategory
saref:hasCommand: s4dmgt:PackageCreationCommand, s4dmgt:PackageDeletionCommand, s4dmgt:PackageDiscoveryCommand, s4dmgt:PackageDownloadCommand, s4dmgt:PackageInformationRetrievalCommand, s4dmgt:PackageInstallCommand, s4dmgt:PackageUninstallCommand, s4dmgt:PackageUpdateCommand

s4dmgt:PackageName — Package name

IRI: https://saref.etsi.org/saref4dmgt/PackageName

is a: owl:Thing
definition: The name of a Device Package.
belongs to: saref:Property
skos:narrower: s4dmgt:PackageProperty

s4dmgt:PackageProperty — Package property

IRI: https://saref.etsi.org/saref4dmgt/PackageProperty
is a: owl:Thing
definition: Property kind that represents the properties of a DevicePackage
belongs to: saref:Property
skos:broader: s4dmgt:PackageName, s4dmgt:PackageVersion

s4dmgt:PackageUninstallCommand — Package uninstall command

IRI: https://saref.etsi.org/saref4dmgt/PackageUninstallCommand
is a: owl:Thing
definition: Command to trigger the uninstallation of a Device Package on a device.
belongs to: s4dmgt:PackageManagementCommandCategory
saref:controls: s4dmgt:PackageProperty

s4dmgt:PackageUpdateCommand — Package update command

IRI: https://saref.etsi.org/saref4dmgt/PackageUpdateCommand
is a: owl:Thing
definition: Command to trigger the update of a Device Package on a device. This corresponds to the action of replacing, on a device, a Device Package by another Device Package with the same name, but a different version.
belongs to: s4dmgt:PackageManagementCommandCategory
saref:controls: s4dmgt:PackageProperty

s4dmgt:PackageVersion — Package version

IRI: https://saref.etsi.org/saref4dmgt/PackageVersion
is a: owl:Thing
definition: The version of a device package.
belongs to: saref:Property
skos:narrower: s4dmgt:PackageProperty

s4dmgt:RebootCommand — Reboot command

IRI: https://saref.etsi.org/saref4dmgt/RebootCommand
is a: owl:Thing
definition: Command to trigger the reboot process of a device.
belongs to: s4dmgt:DeviceControlCommandCategory

s4dmgt:ResetCommand — Reset command

IRI: https://saref.etsi.org/saref4dmgt/ResetCommand
is a: owl:Thing
definition: Command to change the entire state of a device and its resources to another state as predefined according to the device manufacturer policy.
belongs to: s4dmgt:DeviceControlCommandCategory

s4dmgt:SerialNumber — Serial number

IRI: https://saref.etsi.org/saref4dmgt/SerialNumber
is a: owl:Thing
definition: Device identity property referring to the unique identifier assigned to an individual device, used for tracking, warranty, and support purposes, distinguishing it from all other units produced.

belongs to: saref:Property
skos:narrower: s4dmgt:DeviceIdentityProperty

s4dmgt:SupportedDatamodelFunction — Supported datamodel function

IRI: https://saref.etsi.org/saref4dmgt/SupportedDatamodelFunction
is a: owl:Thing
definition: Function kind to manage the supported datamodel of a device.
belongs to: s4dmgt:DeviceManagementFunctionCategory
saref:hasCommand: s4dmgt:SupportedDatamodelRetrievalCommand

s4dmgt:SupportedDatamodelParameterName — Supported datamodel parameter name

IRI: https://saref.etsi.org/saref4dmgt/SupportedDatamodelParameterName
is a: owl:Thing
definition: Name of a supported datamodel parameter.
belongs to: saref:Property
skos:narrower: s4dmgt:SupportedDatamodelParameterProperty

s4dmgt:SupportedDatamodelParameterPrimitives — supported datamodel parameter primitives

IRI: https://saref.etsi.org/saref4dmgt/SupportedDatamodelParameterPrimitives
is a: owl:Thing
definition: Property of a supported datamodel parameter listing the different available primitives for the manipulation of the corresponding Datamodel parameter instance(s).

These primitives will for instance include the basic "Create", "Read", "Update", "Delete" operations and their corresponding names in the different Device Management protocols.
belongs to: saref:Property
skos:narrower: s4dmgt:SupportedDatamodelParameterProperty

s4dmgt:SupportedDatamodelParameterProperty — Supported datamodel parameter property

IRI: https://saref.etsi.org/saref4dmgt/SupportedDatamodelParameterProperty
is a: owl:Thing
definition: Property kind that represents the properties of a Supported Datamodel Parameter.

These parameters represent the capabilities of the Device in a format specific to the datamodel implemented by the Device, and exposed by the Client.

It should not be confused with the Datamodel Parameter Instance, which represents the actionable capabilities of the Device.
belongs to: saref:Property
skos:broader: s4dmgt:SupportedDatamodelParameterName, s4dmgt:SupportedDatamodelParameterPrimitives, s4dmgt:SupportedDatamodelParameterType

s4dmgt:SupportedDatamodelParameterType — Supported datamodel parameter type

IRI: https://saref.etsi.org/saref4dmgt/SupportedDatamodelParameterType
is a: owl:Thing

definition: Type of a supported datamodel parameter.

For instance, this type can represent that the supported datamodel parameter is a reference to an executable resource. The corresponding type would be 'command' in the CWMP standard protocol, and its oneM2M TR-181 technical report.

This type can represent a reference to a measurement process on the device that retrieves a value. In that case, the supported datamodel parameter also describes the unit of that value.

The type 'object' corresponds to a supported datamodel parameter that contains other supported datamodel parameters, creating a hierarchical structure.

A final example would be a 'table', i.e. the corresponding datamodel parameter is a list of instances of the same object.

For more information, refer to the specification documents of DM protocol standards such as oneM2M TR-181 from the BroadBand Forum.

belongs to: saref:Property
skos:narrower: s4dmgt:SupportedDatamodelParameterProperty

s4dmgt:SupportedDatamodelRetrievalCommand — Supported datamodel retrieval command

IRI: https://saref.etsi.org/saref4dmgt/SupportedDatamodelRetrievalCommand
is a: owl:Thing
definition: Command to retrieve a supported datamodel parameter, which corresponds to the information required to access a datamodel parameter instance and interpret its value.
belongs to: s4dmgt:SupportedDatamodelCommandCategory
saref:observes: s4dmgt:SupportedDatamodelParameterProperty

History

Version	Date	Status
V1.1.1	May 2026	Publication