

An Introduction to oneM2M's Smart Device Template and Data Structures

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Introduction

SDT Components

SDT in oneM2M's TS-0023

Semantics

Summary

The Situation So Far (2014)

Too many individual devices and functionalities, different protocols, documentation, and semantics.

- ➔ Hard to understand
- ➔ Hard to align with requirements
- ➔ Difficult to replace
- ➔ Ever-increasing integration efforts for product development

Started in 2014 in the "Home Gateway Initiative" (HGI) to provide a unified method to describe smart home appliances.
oneM2M continues the SDT further to support new requirements for IoT information modeling.



Smart Device Template - Goals

Gain a **common understanding** about capabilities, functionalities and operations.
Provide a **common approach** for abstract device modeling.

Keep it simple, especially for manufacturers to define descriptions about device functionality.

Be **independent** of underlying the IoT domain's network technologies.

Enable uniform APIs for applications.

SDT is not an IoT or data protocol nor a service layer which automatically translates between APIs. It is also not a general data description language.

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Components

A template description is made out of these major components:

- ➔ **Domain**
- ➔ **DeviceClasses**
- ➔ **ModuleClasses**
- ➔ **ProductClasses**

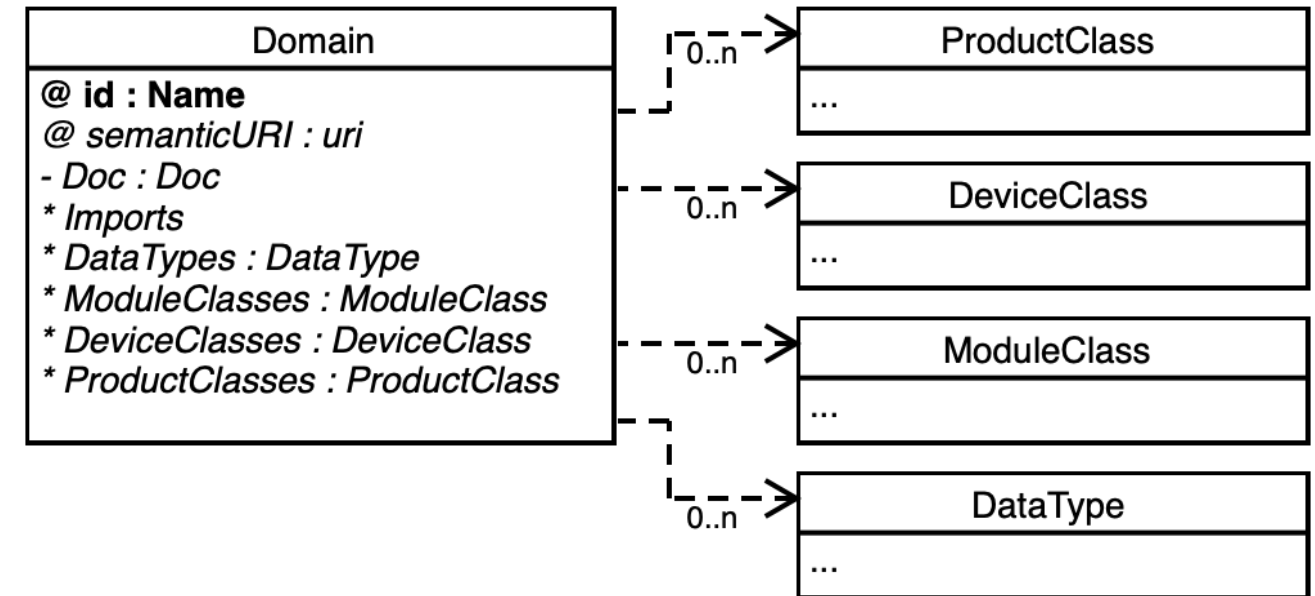
It also allows for the definition of data types, constraints, properties, and more.

Domains

Domains provide "wrappers" which act like namespaces, allowing references to a set of definitions of:

- ➔ **DeviceClasses**
- ➔ **ModuleClasses**
- ➔ **DataTypes**
- ➔ **ProductClasses**

Domains enable distinguishing verticals as shown in TS-0023 R4.

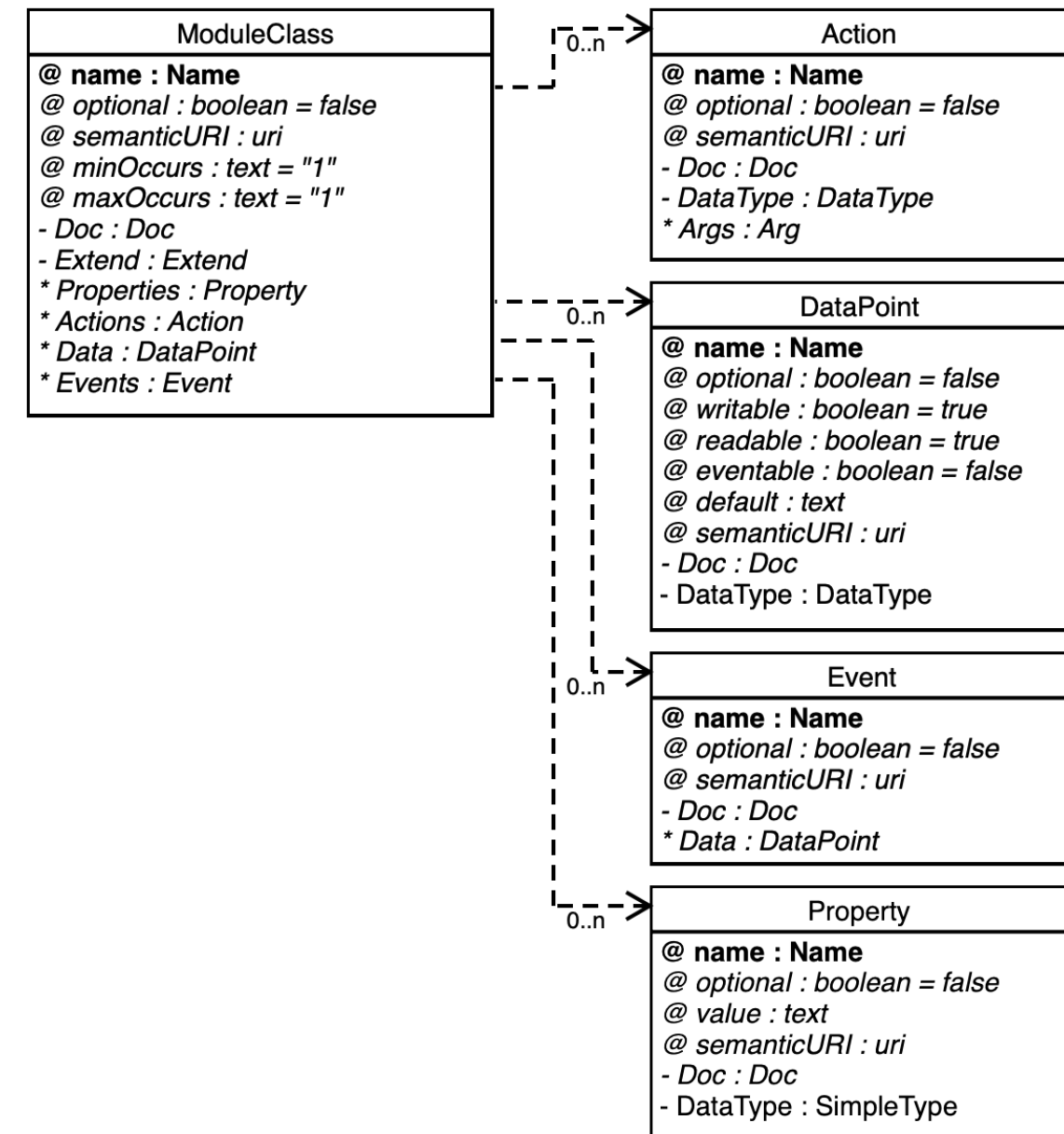


ModuleClasses

A ModuleClass encapsulates functionalities with defined **semantics** and additional **meta-data** to describe aspects of a functionality:

- ➔ **Data points**
- ➔ **Actions**
- ➔ **Events**
- ➔ **Properties**

ModuleClasses support inheritance to enhance existing functionalities.



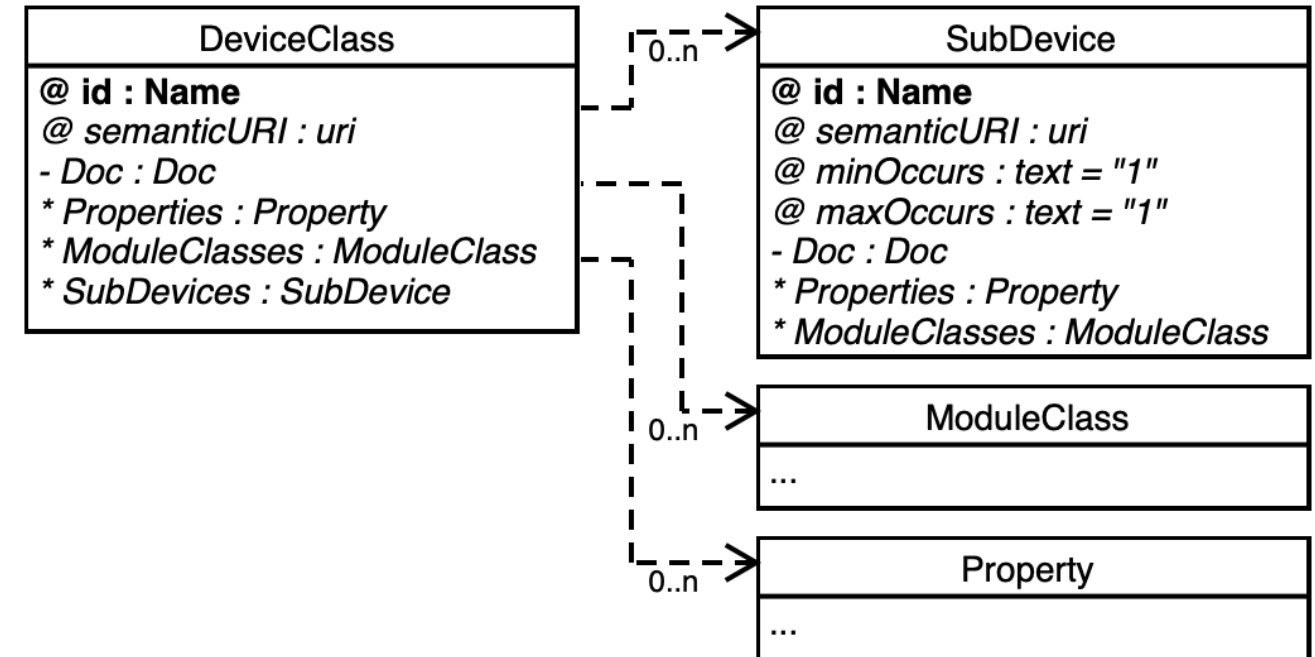
DeviceClasses

A DeviceClass represents a physical, **addressable**, **identifiable** type of appliance, sensor, or actuator, that has one or more functionalities:

➔ **SubDevices**

➔ **ModuleClasses**

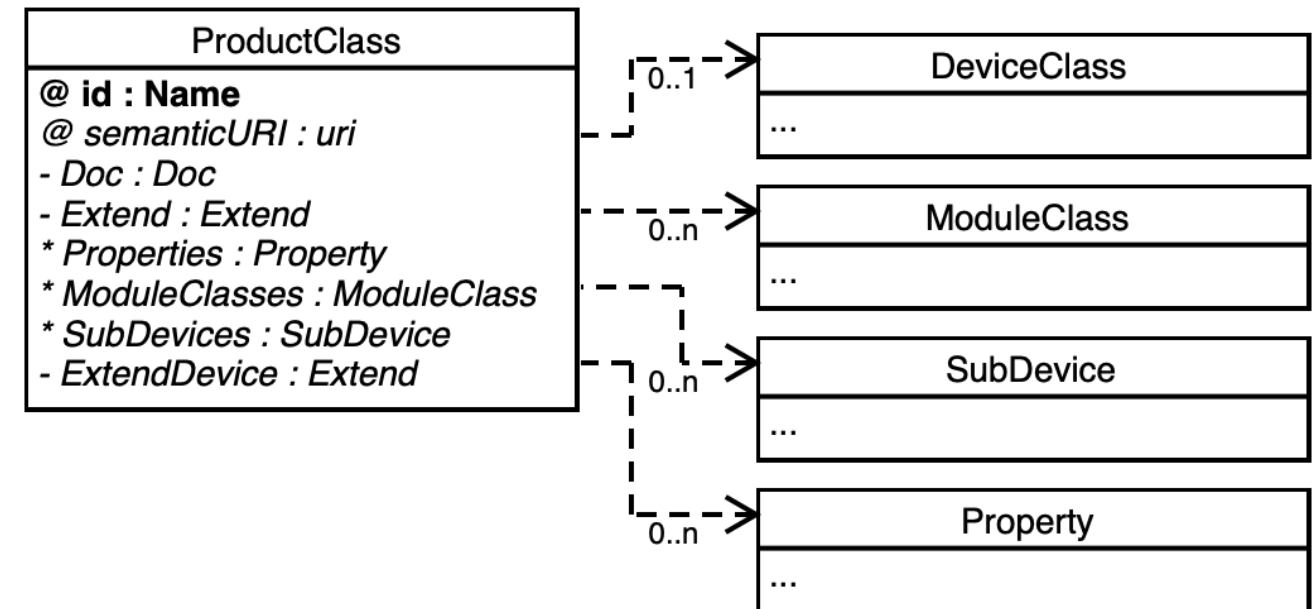
➔ **Properties**



ProductClasses

A ProductClass is a concrete device model with fixed device Properties and ModuleClasses without optionality, and for a specialized manufacturer implementation.

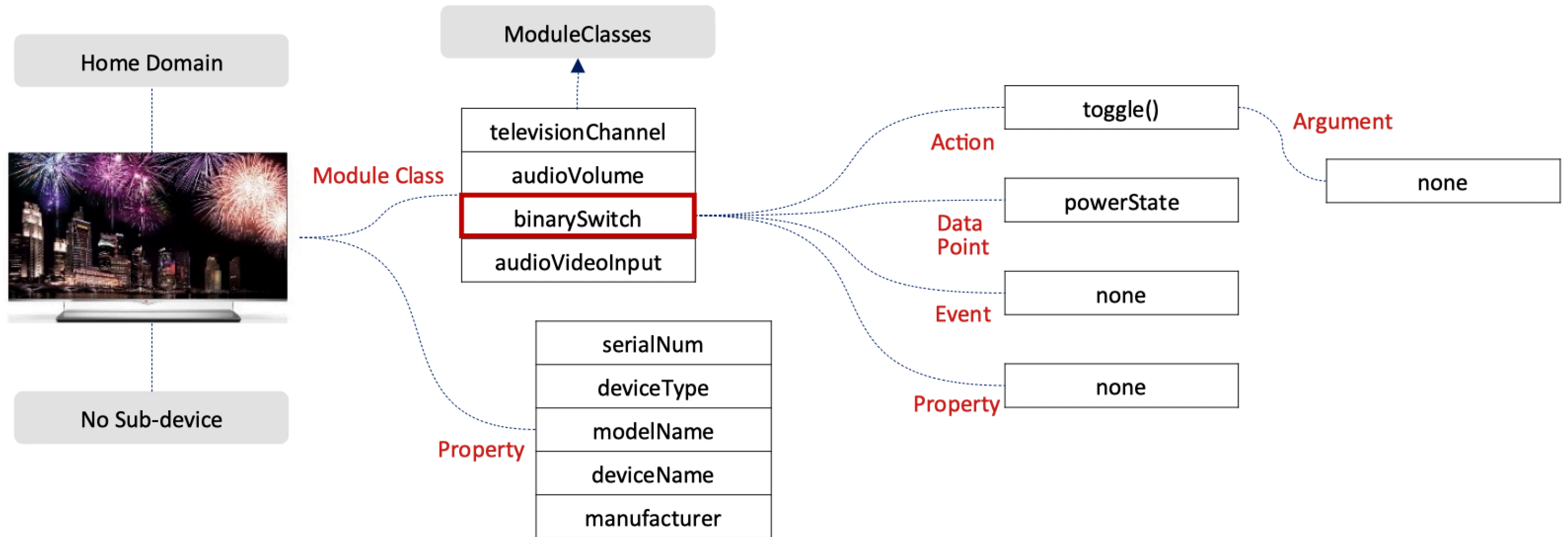
- ➔ **DeviceClass**
- ➔ **SubDevices**
- ➔ **ModuleClasses**
- ➔ **Properties**



It implements DeviceClass or ModuleClass functionalities while specifying the elements to include or exclude.

ProductClasses is a concept that is NOT used in oneM2M specifications directly, but allows vendors and integrators to continue to use the same tool to model real products.

Example - A TV Set DeviceClass



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TS-0023 - SDT Modeling Process

SDT is the basis for modeling in TS-0023. This TS is a living document that gets updated with new additions between releases. Rules define the mappings to oneM2M resources:

- ➔ A **<flexContainer>** is a resource type that can be extended with custom attributes. This is called a **[specialization]**.
- ➔ ModuleClasses, DeviceClasses and Actions are **mapped to a hierarchy of [specializations]**. DataPoints, Properties and Action arguments are mapped to individual custom attributes.
- ➔ Also: Specifying units of measure and optionality for data points, careful examination of new proposed functionalities and changes to existing ones, assigning to domains, creating the formal oneM2M XSDs and data types as well as short names for new **[specializations]** and custom attributes.

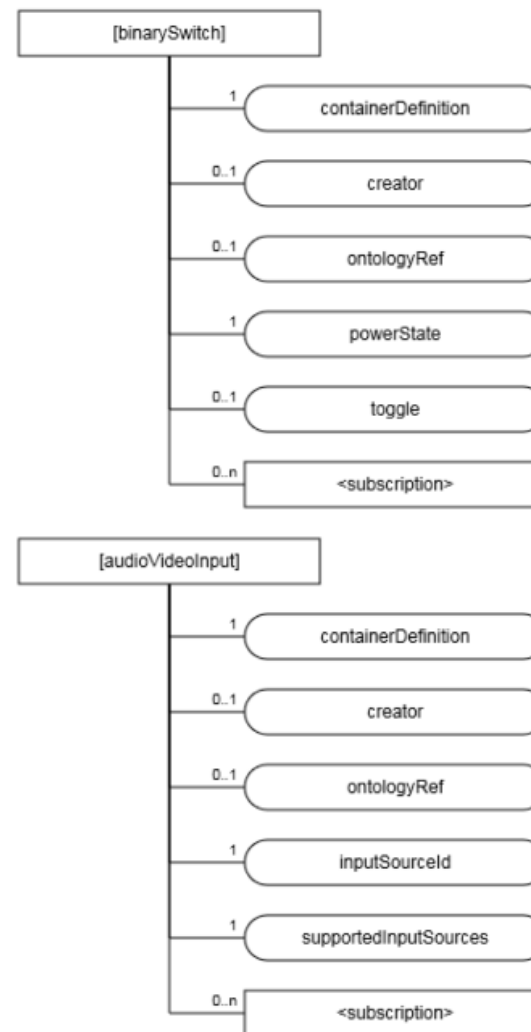
TS-0023 - SDT Modeling Process

SDT Modeling



- **Property**
 - country
 - deviceID
 - deviceType
 - deviceName
 - deviceModelName
 - ...
- **Module**
 - binarySwitch
 - audioVolume
 - televisionChannel
 - audioVideoInput
 - mediaSourceList

Resource Mapping



SDT Mapping

```
<ModuleClass name="binarySwitch">  
  <Doc>This ModuleClass provides capabilities to control and monitor the state of  
  power.</Doc>  
  <Actions>  
    <Action name="toggle" optional="true">  
      <Doc>Toggle the switch.</Doc>  
    </Action>  
  </Actions>  
  <Data>  
    <DataPoint name="powerState" readable="true" writable="true" eventable="true"  
    optional="false">  
      <Doc>The current status of the binarySwitch. "True" indicates turned-on,  
      and "False" indicates turned-off.</Doc>  
      <DataType>  
        <SimpleType type="boolean" />  
      </DataType>  
    </DataPoint>  
  </Data>  
</ModuleClass>
```

XSD Mapping

```
<xs:element name="binarySwitch" type="hd:binarySwitch" />  
<xs:complexType name="binarySwitch">  
  <xs:complexContent>  
    <xs:extension base="m2m:flexContainerResource">  
      <xs:sequence>  
        <!-- Resource Specific Attributes -->  
        <xs:element name="powerState" type="xs:boolean" />  
        <!-- Child Resources -->  
        <xs:choice minOccurs="0" maxOccurs="1">  
          <xs:element name="childResource" type="m2m:childResourceRef" minOccurs="1"  
            maxOccurs="unbounded" />  
          <xs:choice minOccurs="1" maxOccurs="unbounded">  
            <xs:element ref="hd:toggle" />  
            <xs:element ref="m2m:subscription" />  
          </xs:choice>  
        </xs:choice>  
      </xs:sequence>  
    </xs:extension>  
  </xs:complexContent>  
</xs:complexType>
```

SDT Domains

TS-0023

- ➔ agriculture
- ➔ city
- ➔ common
- ➔ health
- ➔ home

- ➔ industry
- ➔ management
- ➔ metadata
- ➔ railway
- ➔ vehicular

TS-0037

- ➔ Public Warning System

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Semantic Descriptor & Base Ontology

Besides the written specifications for each DeviceClass, ModuleClass, data point etc. in TS-0023 many oneM2M resources, including <flexContainer>, can be annotated with **<semanticDescriptor>** resources.

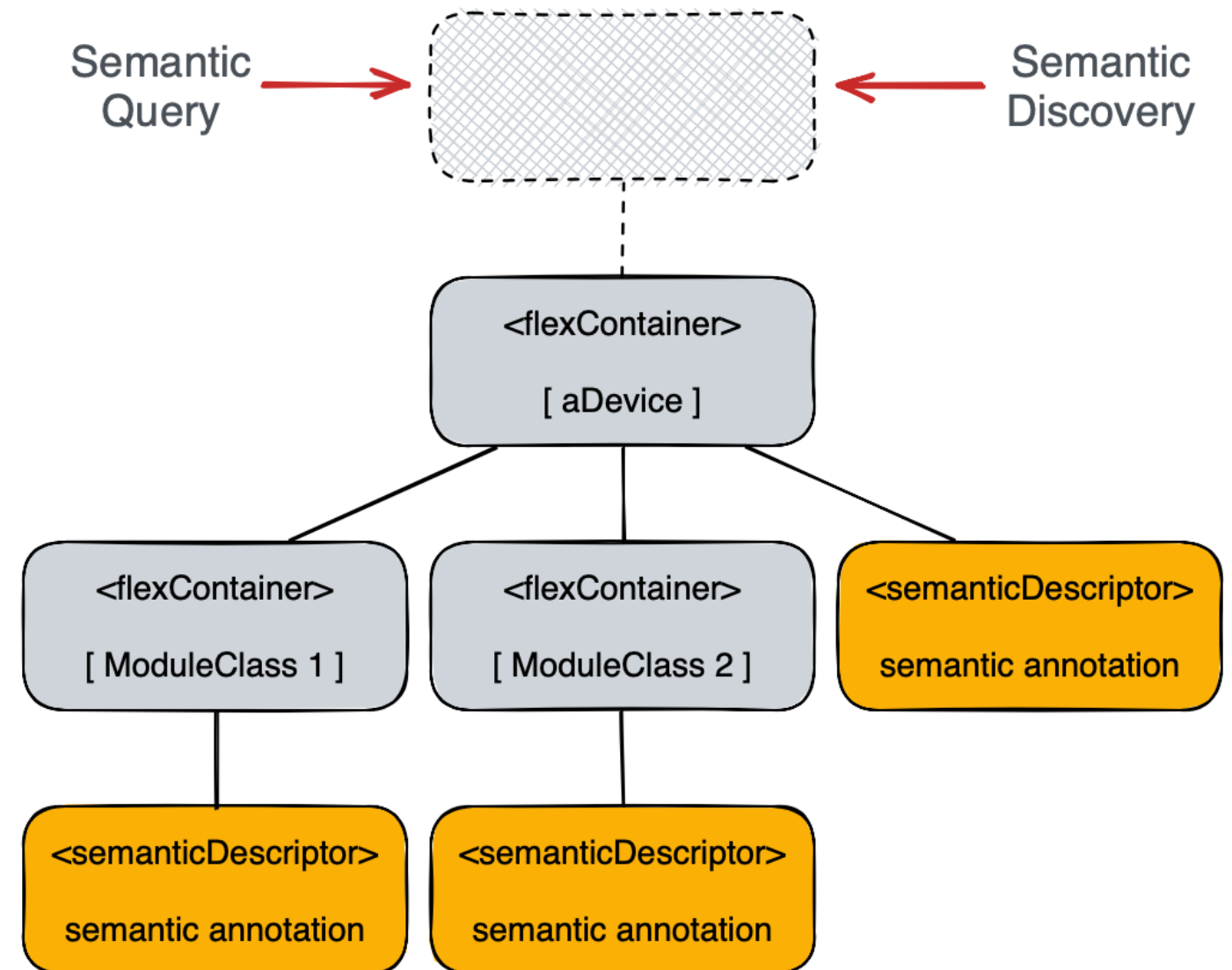
This resource type is used to store semantic descriptions pertaining to a resource and potentially sub-resources.

oneM2M specifies a **Base Ontology** in TS-0012. It specifies the minimal ontology (i.e. mandating the least number of conventions) that is required such that other ontologies can be mapped into oneM2M.

Semantic Operations

The <SMD>'s descriptions are used by oneM2M's semantic functions and are available to applications and CSEs.

- ➔ **Semantic Queries** are made against the aggregated graph of an accessible resource sub-tree.
- ➔ **Semantic Discovery** discovers resources by their semantic annotations.



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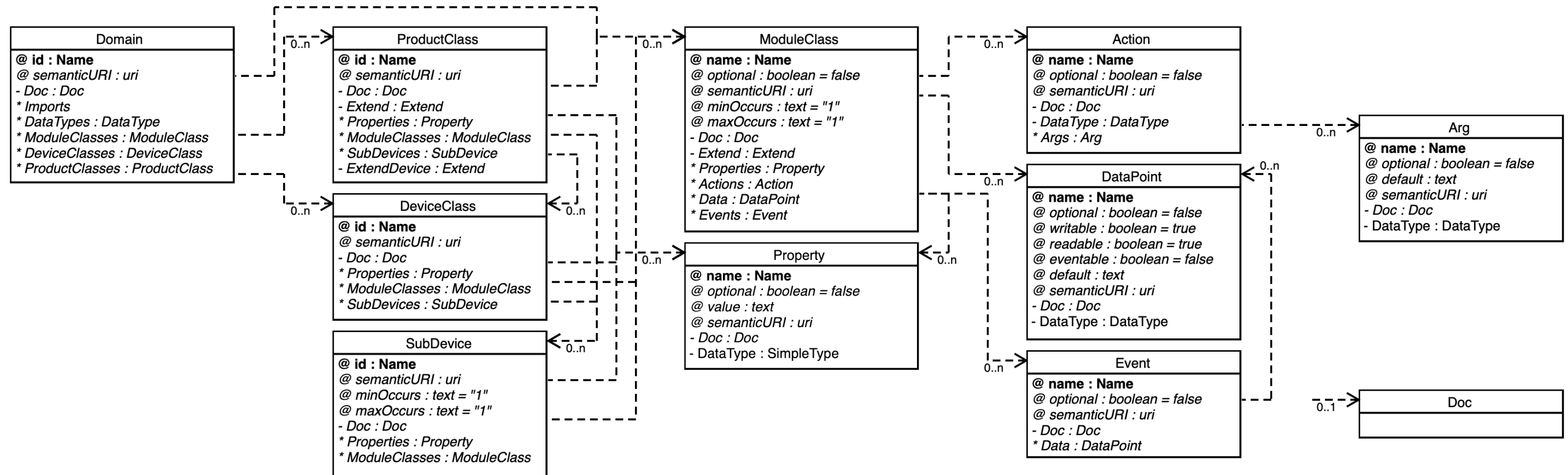
Summary

- ➔ The Smart Device Template (SDT) is a template method that is used to model the capabilities, information models, and semantics of connected devices.
- ➔ oneM2m uses, together with other organizations, the SDT to collect, model, and specify ModuleClasses and DeviceClasses for vertical industries in TS-0023.
- ➔ A large number of already specified ModuleClasses are the building blocks that cover a wide variety of use cases.
- ➔ Standardized mappings to oneM2M resources and technologies ensure further interoperability inside the oneM2M eco-system.
- ➔ oneM2M's supports semantic annotations, query and discovery functionality as well as provides a Base Ontology to support mappings to other ontologies.

Thank You!

Annex - UML Diagrams

SDT 4.0 - Basic Elements



SDT 4.0 - Data Types & Extend

