

Tutorial

Specification Asset Administration Shell
Part 2 API v3.0

Release of V3 Metamodel and REST API



Specification of the Asset Administration Shell
Part 5: Package File Format (AASX)
Specification of the Asset Administration Shell Part 5: Package File Format (AASX)
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A blue rectangular graphic with white and orange text. At the top left is the IDTA logo and 'Industrial Digital Twin Association'. The main text reads 'Tutorial Specification Asset Administration Shell Part 1 Metamodel V3.0 April 2023'. At the bottom, it says 'Tutorial – Specification Asset Administration Shell Part 1: Metamodel, V3.0' and includes a 'Download' button with an orange arrow pointing right.

IDTA Industrial Digital Twin Association

Tutorial

Specification
Asset Administration Shell
Part 1 Metamodel V3.0 April 2023

Tutorial – Specification Asset Administration Shell Part 1: Metamodel, V3.0

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<https://www.youtube.com/watch?v=f1EtKLAkdnl>

https://industrialdigitaltwin.org/wp-content/uploads/2023/05/V3.0_Specification_AAS_Part1_Metamodel.pdf



„Thank you Task Force REST API!“



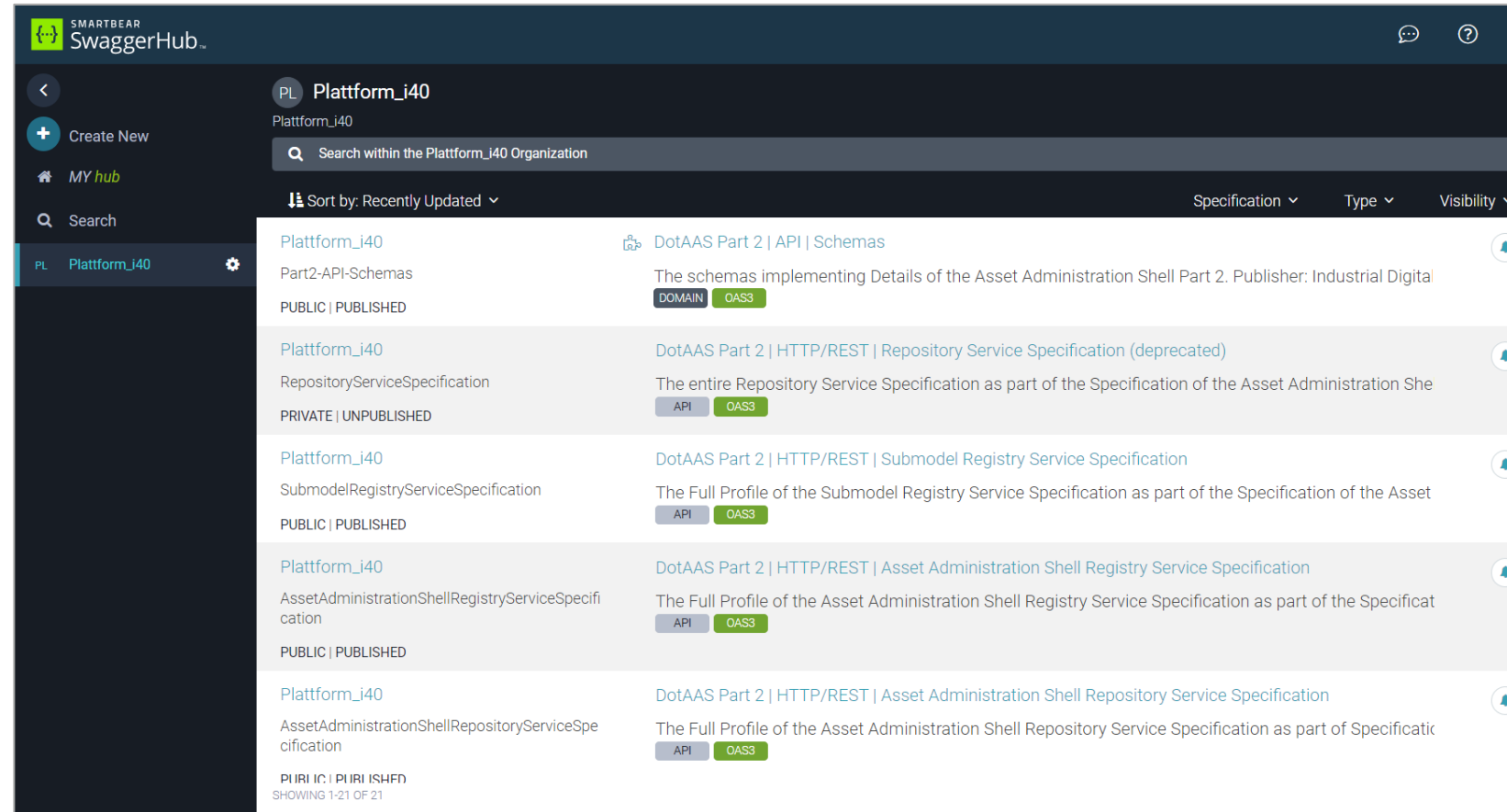
Leads:
Sebastian Bader (SAP)
Andreas Orzelski (Phoenix Contact)

```
1 openapi: 3.0.3
2 info:
3   title: DotAAS Part 2 | HTTP/REST | Repository Service Specification
4   description: "The entire Repository Service Specification as part
5     of Details of the Asset Administration Shell Part 2 - Copyright:
6     Industrial Digital Twin Association (IDTA) 2023"
7   contact:
8     name: Industrial Digital Twin Association (IDTA)
9     email: info@idtwin.org
10    license:
11      name: CC BY-SA 4.0
12      url: https://creativecommons.org/licenses/by-sa/4.0/
13  version: V3.0
14  termsOfService: https://github.com/admin-shell-io/aas-specs
15  servers:
16    - url: "{protocol}://{host_name}:{port}/api/{version_prefix}"
17      variables:
18        protocol:
19          description: "Allows access through http and https (recommended)"
20          enum:
21            - http
22            - https
23          default: https
24        host_name:
25          description: "Hostname of server hosting the api"
26          default: admin-shell.io
27        port:
28          enum:
29            - 80
30            - 443
31          default: 443
32          description: "80 is default for http, 443 for https"
33        version_prefix:
34          enum:
35            - v3.0
36          default: v3.0
37  paths:
38    /shells:
39      get:
40        summary: Returns all Asset Administration Shells
41        operationId: GetAllAssetAdministrationShells
42        x-semverInfo:
43          - https://admin-shell.io/aas/API
44            /GetAllAssetAdministrationShells/3/0
45          - https://admin-shell.io/aas/API
46            /GetAllAssetAdministrationShellsByAssetId/3/0
47          - https://admin-shell.io/aas/API
48            /GetAllAssetAdministrationShellsByIdShort/3/0
49        parameters:
50          - $ref: "https://api.swaggerhub.com/domains/Plattform_140
```

New Features in V3.0:

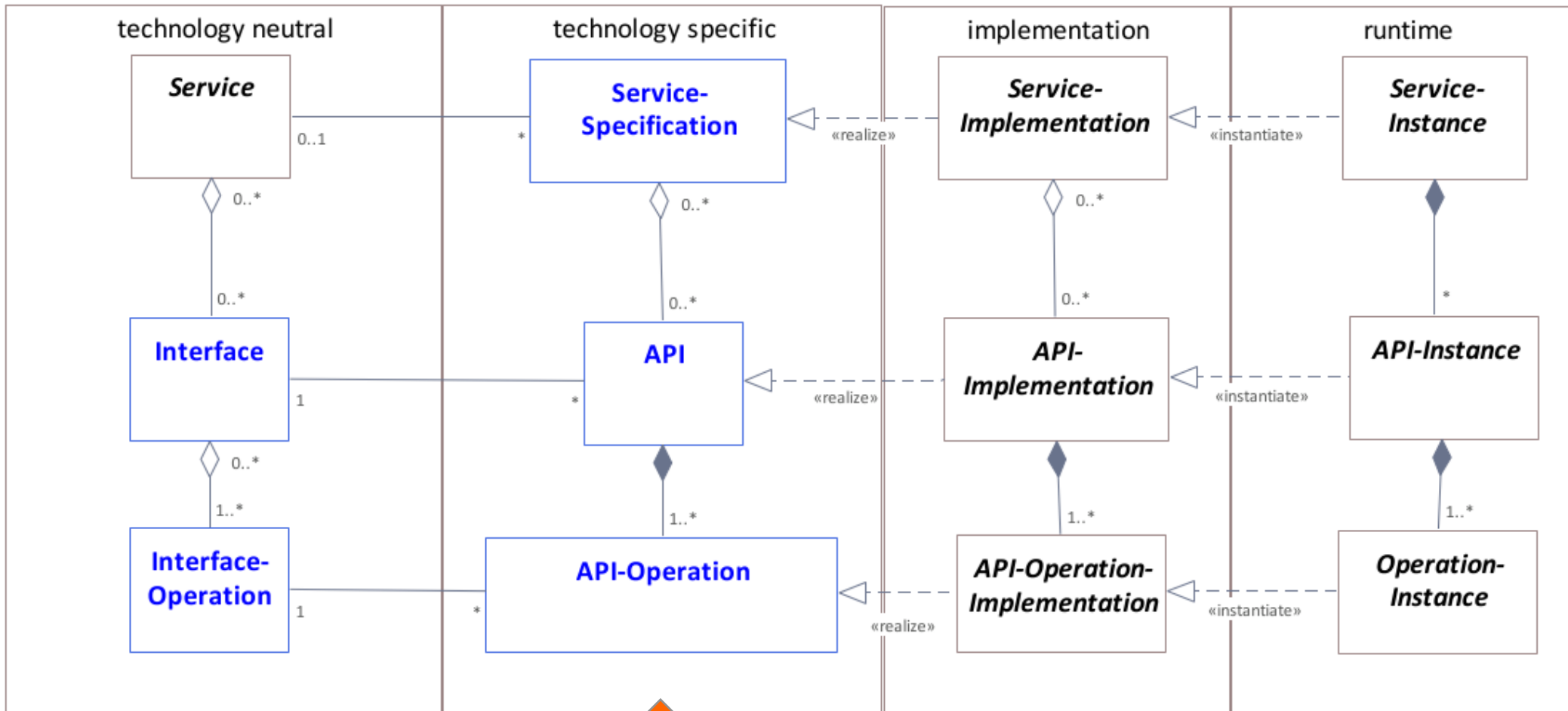
- Make Part 1 changes also in Part 2
- Patch Submodel
- Pagination to enable large-scale applications
- SerializationModifier Content as route for result type safety, e.g. \$value
- API versioning with major + minor
- Profiles enabling certification

IDTA Specification + OpenAPIs on SwaggerHub



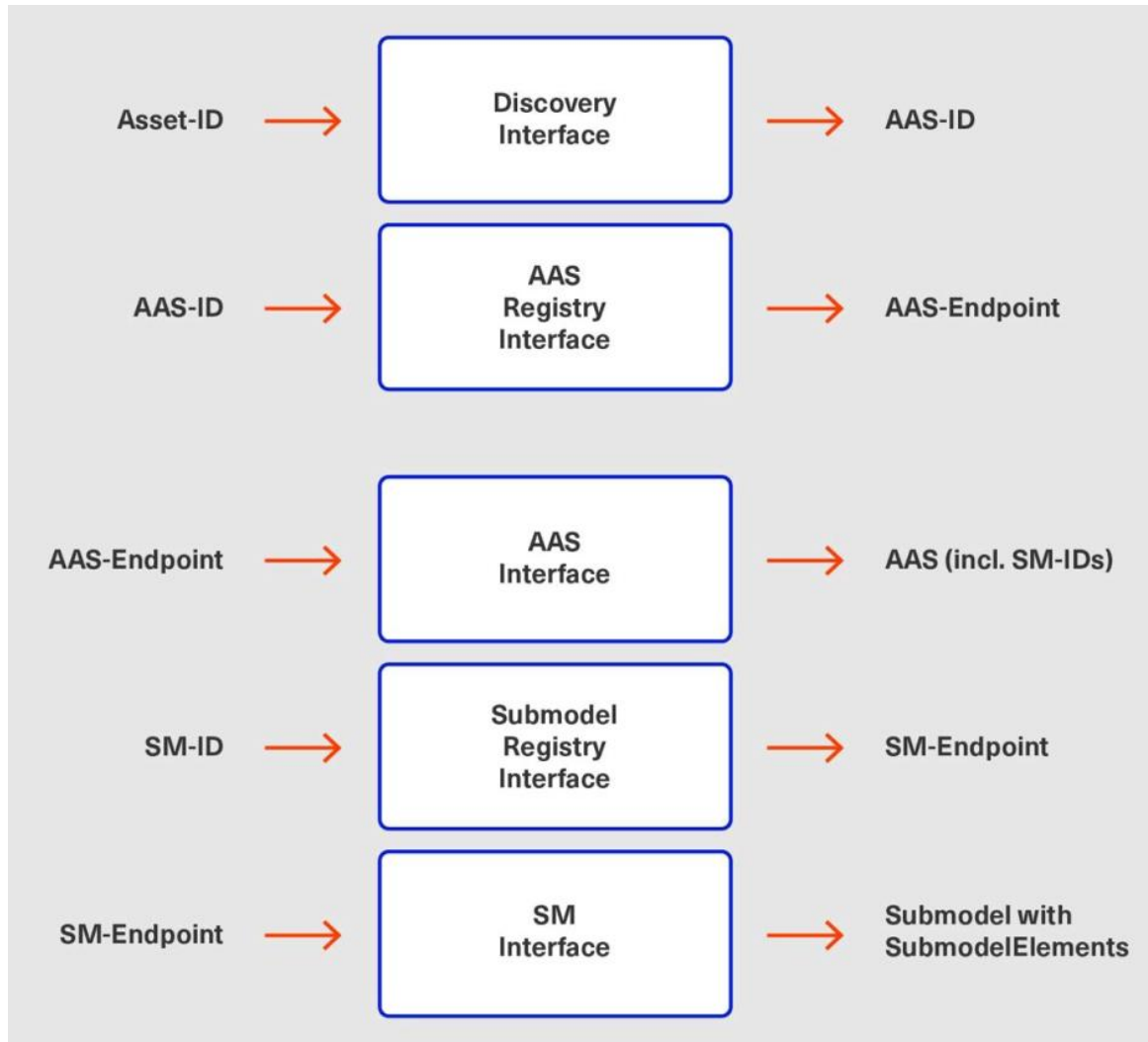
<https://industrialdigitaltwin.org/en/content-hub/downloads>
https://app.swaggerhub.com/organizations/Platform_i40

Figure 2: Services, Interfaces & APIs and Operations

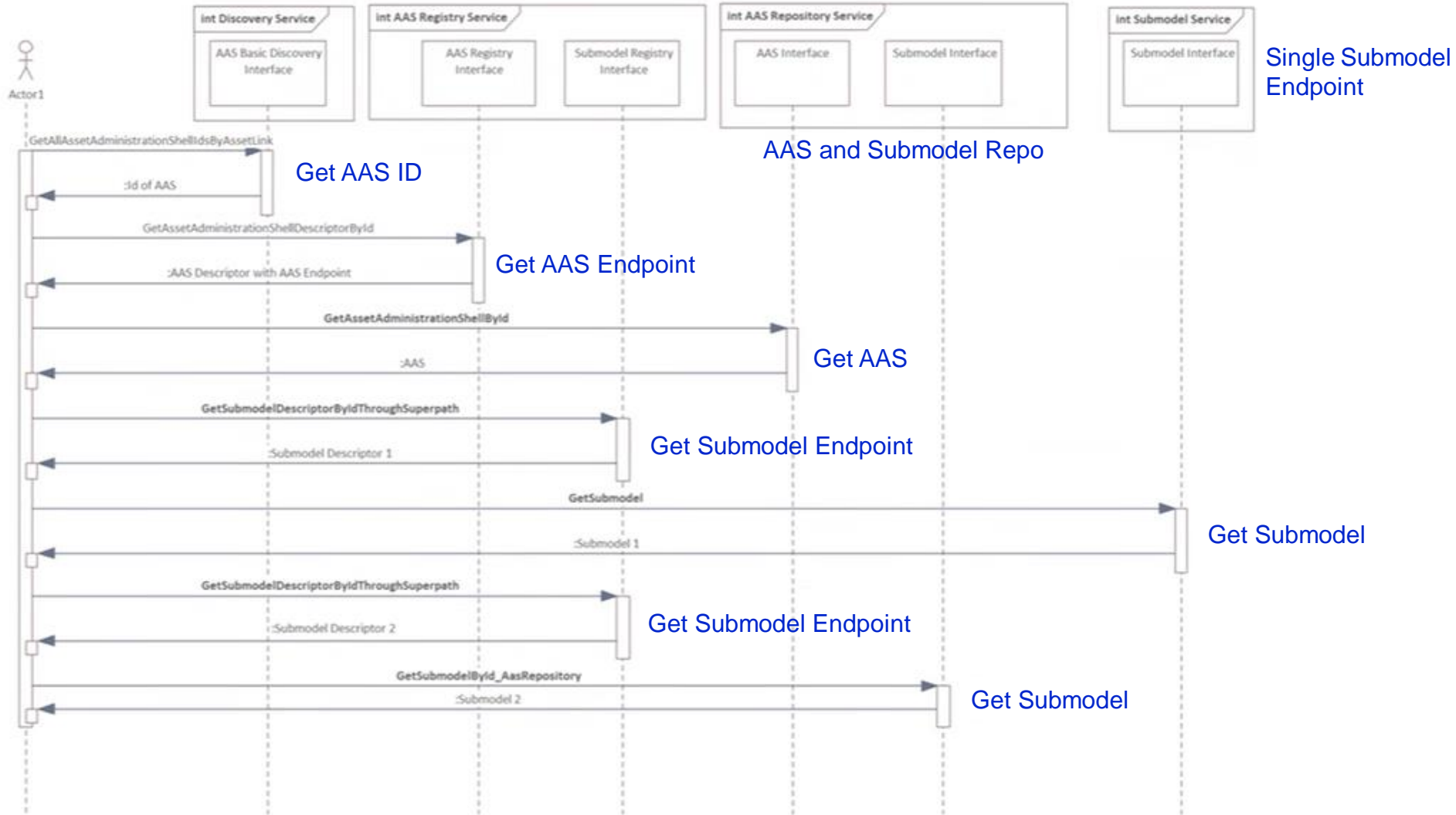


 REST API

Figure 3: Retrieval of AAS and Submodels for Assets



Submodel Repository and/or Submodel Endpoint





- Asset Administration Shell Interface
- Submodel Interface

- Asset Administration Shell Repository Interface
- Submodel Repository Interface
- Concept Description Repository Interface

- Asset Administration Shell Basic Discovery Interface
- Asset Administration Shell Registry Interface
- Submodel Registry Interface

- AASX File Server Interface

- Self-Description Interface

- [Asset Administration Shell Service Specification](#)
- [Submodel Service Specification](#)

- [Asset Administration Shell Repository Service Specification](#)
- [Submodel Repository Service Specification](#)
- [Concept Description Repository Service Specification](#)

- [Discovery Service Specification](#)
- [Asset Administration Shell Registry Service Specification](#)
- [Submodel Registry Service Specification](#)

- [AASX File Server Service Specification](#)

Example: Submodel Interface and OpenAPI

Submodel Service Specification

5.3 Submodel Interface and Operations

5.3.1 Submodel Interface

Operation Name	Description
GetSubmodel	Returns the Submodel
GetAllSubmodelElements	Returns all submodel elements including their hierarchy
GetSubmodelElementByPath	Returns a specific submodel element from the Submodel at a specified path
GetFileByPath	Returns a specific file from the Submodel at a specified path
PutFileByPath	Replaces the file of an existing submodel element at a specified path within the submodel element hierarchy
DeleteFileByPath	Deletes the file of an existing submodel element at a specified path within the submodel element hierarchy
PutSubmodel	Replaces the Submodel
PatchSubmodel	Updates the Submodel
PostSubmodelElement	Creates a new submodel element as a child of the submodel. The idShort of the new submodel element must be set in the payload.
PostSubmodelElementByPath	Creates a new submodel element at a specified path within the submodel elements hierarchy. The idShort of the new submodel element must be set in the payload.
PutSubmodelElementByPath	Replaces an existing submodel element at a specified path within the submodel element hierarchy
PatchSubmodelElementByPath	Updates an existing submodel element at a specified path within the submodel element hierarchy
GetSubmodelElementValueByPath	Returns the value of the submodel element at a specified path according to the protocol-specific RAW-value payload
DeleteSubmodelElementByPath	Deletes a submodel element at a specified path within submodel element hierarchy
InvokeOperationSync	Synchronously invokes an Operation at a specified path with a client timeout in ms
InvokeOperationAsync	Asynchronously invokes an Operation at a specified path with a client timeout in ms

```
1 openapi: 3.0.3
2 info:
3   title: DotAAS Part 2 | HTTP/REST | Submodel Service Specification
4   description: "The Full Profile of the Submodel Service Specification as part of Details of the Asset Administration Shell Part 2. Publisher: Industrial Digital Twin Association (IDTA) April 2023"
5   contact:
6     name: Industrial Digital Twin Association (IDTA)
7     email: info@idtwins.org
8   license:
9     name: CC BY 4.0
10    url: https://creativecommons.org/licenses/by/4.0/
11    version: V3.0_SSP-001
12 servers:
13 - url: '{protocol}://{host_name}:{port}/api/{version_prefix}'
14   variables:
15     protocol:
16       description: 'Allows access through http and https (recommended)'
17       enum:
18         - 'http'
19         - 'https'
20       default: 'https'
21     host_name:
22       default: admin-shell.io
23       description: 'Hostname of server hosting the api'
24     port:
25       enum:
26         - '80'
27         - '443'
28       default: '443'
29       description: '80 is default for http, 443 for https'
30     version_prefix:
31       enum:
32         - 'v3.0'
33       default: v3.0
34 paths:
35   /submodel:
36     get:
37       tags:
38         - Submodel API
39       summary: Returns the Submodel
40       operationId: GetSubmodel
41       x-semanticId:
42         - https://admin-shell.io/aas/API/GetSubmodel/3/0
43       parameters:
44         - $ref: https://api.swaggerhub.com/domains/Plattform_i40/Part2-API-Schemas/V3.0#/components/parameters/Level
45         - $ref: https://api.swaggerhub.com/domains/Plattform_i40/Part2-API-Schemas/V3.0#/components/parameters/Extent
46
```

HTTP Methods used



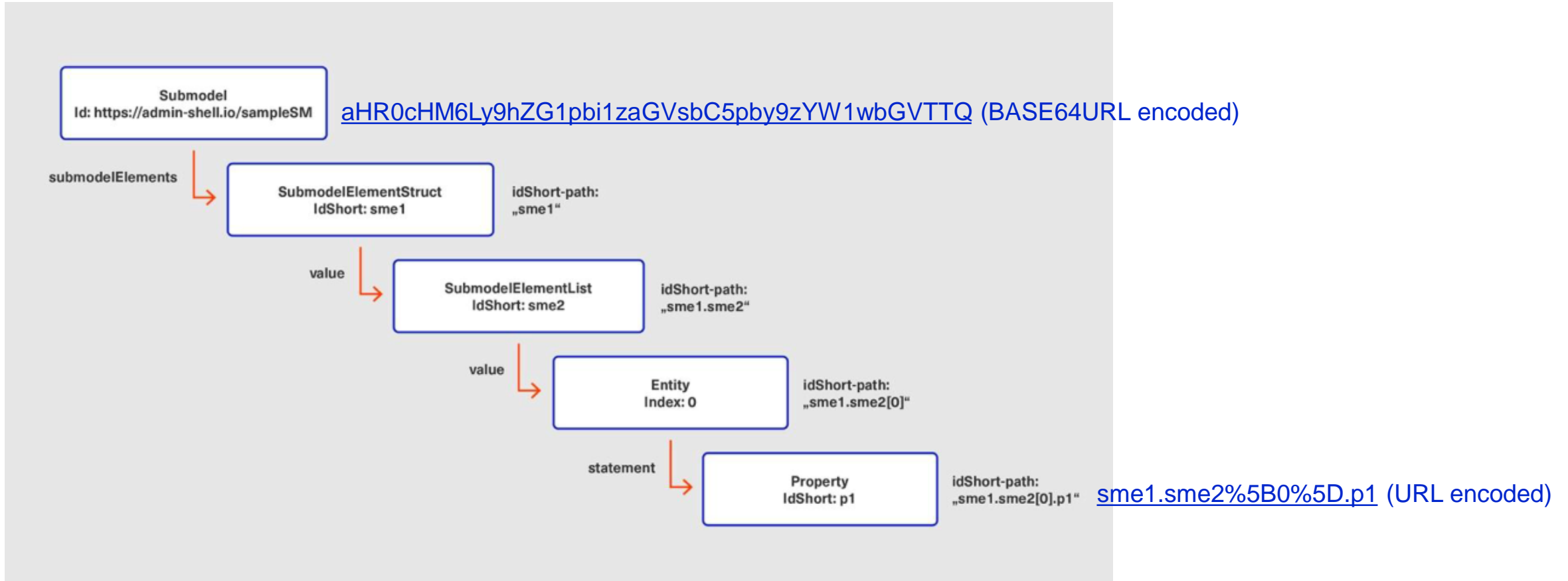
HTTP Method	Explanation
GET	Returns a single resource (or list of resources) based on the resource identifier which is the identifier for identifiable and the idShortPath for referables.
POST	Creates a new resource. The identifier of the resource is part of the resource description.
PUT	Replaces an existing resource.
PATCH	Updates an existing resource. The structure of the existing resource on the server and of the content given by the PATCH must be the same.
DELETE	Deletes a resource based on a given identifier.
POST	Invokes an operation.

Further Important Topics in V3.0



- IdShortPath
- BASE64URL encoded identifiers
- SerializationModifiers
- Pagination
- API versioning
- Profiles
- Description Interface
- Patch Submodel

IdShort Path and BASE64URL encoded identifiers



GET /submodels/[aHR0cHM6Ly9hZG1pbi1zaGVsbC5pby9zYW1wbGVVTTQ](#)/submodel/submodelElements/[sme1.sme2%5B0%5D.p1](#)

Serialization Modifiers

Table 5 Level Parameters

Value	Explanation
Deep (Default)	All elements of a requested hierarchy level and all children on all sublevels are returned. Children in this sense are SubmodelElements which are contained at the 'submodelElements' field of Submodels, the 'value' field of SubmodelElementCollections or SubmodelElementLists, the 'statements' field of Entities, or the 'annotations' field of AnnotatedRelationshipElements.
Core	Only elements of a requested hierarchy level as well as direct children are returned. By this, a client can iterate the hierarchy step by step.

?level=deep or ?level=core

Table 6 Content Parameters

Value	Explanation
Normal (Default)	The standard serialization of the model element or child elements is applied.
Metadata	Only metadata of an element or child elements is returned; the value is not.
Value	Only the raw value of the model element or child elements is returned; it is commonly referred to as <i>ValueOnly</i> -serialization.
Reference	Only applicable to Referables. Only the reference to the found element is returned; potential child elements are ignored.

Table 7 Extent Parameters

/\$metadata,/\$value, /\$reference, /\$path

Value	Explanation
WithoutBLOBValue (Default)	Only applicable to BLOB-elements; the BLOB content is not returned.
WithBLOBValue	Only applicable to BLOB-elements; the BLOB content is returned as <i>base64</i> -encoded string.

?extent=withBlobValue or ?extent=withoutBlobValue

```

GET /submodel
PUT /submodel
PATCH /submodel
GET /submodel/$metadata
PATCH /submodel/$metadata
GET /submodel/$value
PATCH /submodel/$value
GET /submodel/$reference
GET /submodel/$path
GET /submodel/submodel-elements
POST /submodel/submodel-elements
GET /submodel/submodel-elements/$metadata
GET /submodel/submodel-elements/$value
GET /submodel/submodel-elements/$reference
GET /submodel/submodel-elements/$path
GET /submodel/submodel-elements/{idShortPath}
POST /submodel/submodel-elements/{idShortPath}
PUT /submodel/submodel-elements/{idShortPath}
PATCH /submodel/submodel-elements/{idShortPath}
DELETE /submodel/submodel-elements/{idShortPath}
GET /submodel/submodel-elements/{idShortPath}/$metadata
PATCH /submodel/submodel-elements/{idShortPath}/$metadata
GET /submodel/submodel-elements/{idShortPath}/$value
PATCH /submodel/submodel-elements/{idShortPath}/$value
GET /submodel/submodel-elements/{idShortPath}/$reference
GET /submodel/submodel-elements/{idShortPath}/$path
GET /submodel/submodel-elements/{idShortPath}/attachment
        
```

Raw Parsed

```

{
  "ManufacturerName": "Festo SE & Co. KG",
  "ManufacturerProductDesignation": "Electric cylinder with spindle drive",
  "PhysicalAddress": {
    "CountryCode": "de",
    "Street": "Ruiter Strasse 82",
    "Zip": "73734",
    "CityTown": "Esslingen am Neckar",
    "StateCounty": "Baden-Württemberg"
  },
  "ManufacturerProductFamily": "VUVG-L14-T32C-AT-G18-1R8L",
  "ProductCountryOfOrigin": "de",
  "YearOfConstruction": "2020",
  "Marking_CE": {
    "CEQualificationPresent": "1",
    "File": {
      "contentType": "",
      "value": "/aasx/Nameplate/CE_Marking_2016.png"
    }
  }
}
        
```

Example:
GET /submodel/\$value

⋮ Pagination

Table 14 Parameters for Pagination

Parameter	Values	Default	Explanation
Cursor	string	-	The position from which to resume a result listing. The value may be base64url-encoded and contain additional information which helps the server to respond more efficiently. However, the client must not expect any meaning and treat the cursor value as an arbitrary character sequence. The server must interpret a missing cursor as if the client wants to retrieve the first part of the result set.
Limit	nonNegativeInteger	100	The maximum size of the result list.

- Cursor based pagination
- Registry, AAS, Submodels

```

36 /shells:
37 get:
38 tags:
39   - Asset Administration Shell Repository API
40 summary: Returns all Asset Administration Shells
41 operationId: GetAllAssetAdministrationShells
42 x-semanticIds:
43   - https://admin-shell.io/aas/API
44     /GetAllAssetAdministrationShells/3/0
45   - https://admin-shell.io/aas/API
46     /GetAllAssetAdministrationShellsByAssetId/3/0
47   - https://admin-shell.io/aas/API
48     /GetAllAssetAdministrationShellsByIdShort/3/0
49 parameters:
50   - $ref: 'https://api.swaggerhub.com/domains/Plattform_i40
51     /Part2-API-Schemas/V3.0#/components/parameters/AssetIds'
52   - $ref: 'https://api.swaggerhub.com/domains/Plattform_i40
53     /Part2-API-Schemas/V3.0#/components/parameters/IdShort'
54   - $ref: 'https://api.swaggerhub.com/domains/Plattform_i40
55     /Part2-API-Schemas/V3.0#/components/parameters/Limit'
56   - $ref: 'https://api.swaggerhub.com/domains/Plattform_i40
57     /Part2-API-Schemas/V3.0#/components/parameters/Cursor'
58 responses:
59   '200':
60     description: Requested Asset Administration Shells
61     content:
62       application/json:
63         schema:
64           $ref: 'https://api.swaggerhub.com/domains
65             /Plattform_i40/Part2-API-Schemas/V3.0#
66             /components/schemas
67             /GetAssetAdministrationShellsResult'

```

```

387 GetAssetAdministrationShellsResult:
388 allOf:
389   - $ref: '#/components/schemas/PagedResult'
390   - type: object
391     properties:
392       result:
393         type: array
394         items:
395           $ref: "https://api.swaggerhub.com/domains
396             /Plattform_i40/Part1-MetaModel-Schemas/V3.0#
397             /components/schemas/AssetAdministrationShell"

```

```

584 PagedResult:
585 type: object
586 properties:
587   paging_metadata:
588     type: object
589     properties:
590       cursor:
591         type: string
592         example: wJlCDLl16KTWypN7T6vc6nWEmEYe99Hjf1XY1xmqV-M
593         =#

```

SCHEMA	GetAssetAdministrationShellDescriptorsResult
SCHEMA	GetAssetAdministrationShellsMetadataResult
SCHEMA	GetAssetAdministrationShellsResult
SCHEMA	GetConceptDescriptionsResult
SCHEMA	GetPackageDescriptionsResult
SCHEMA	GetPathItemsResult
SCHEMA	GetReferencesResult
SCHEMA	GetSubmodelDescriptorsResult
SCHEMA	GetSubmodelElementsMetadataResult
SCHEMA	GetSubmodelElementsResult
SCHEMA	GetSubmodelElementsValueResult
SCHEMA	GetSubmodelsMetadataResult
SCHEMA	GetSubmodelsResult
SCHEMA	GetSubmodelsValueResult

API versioning



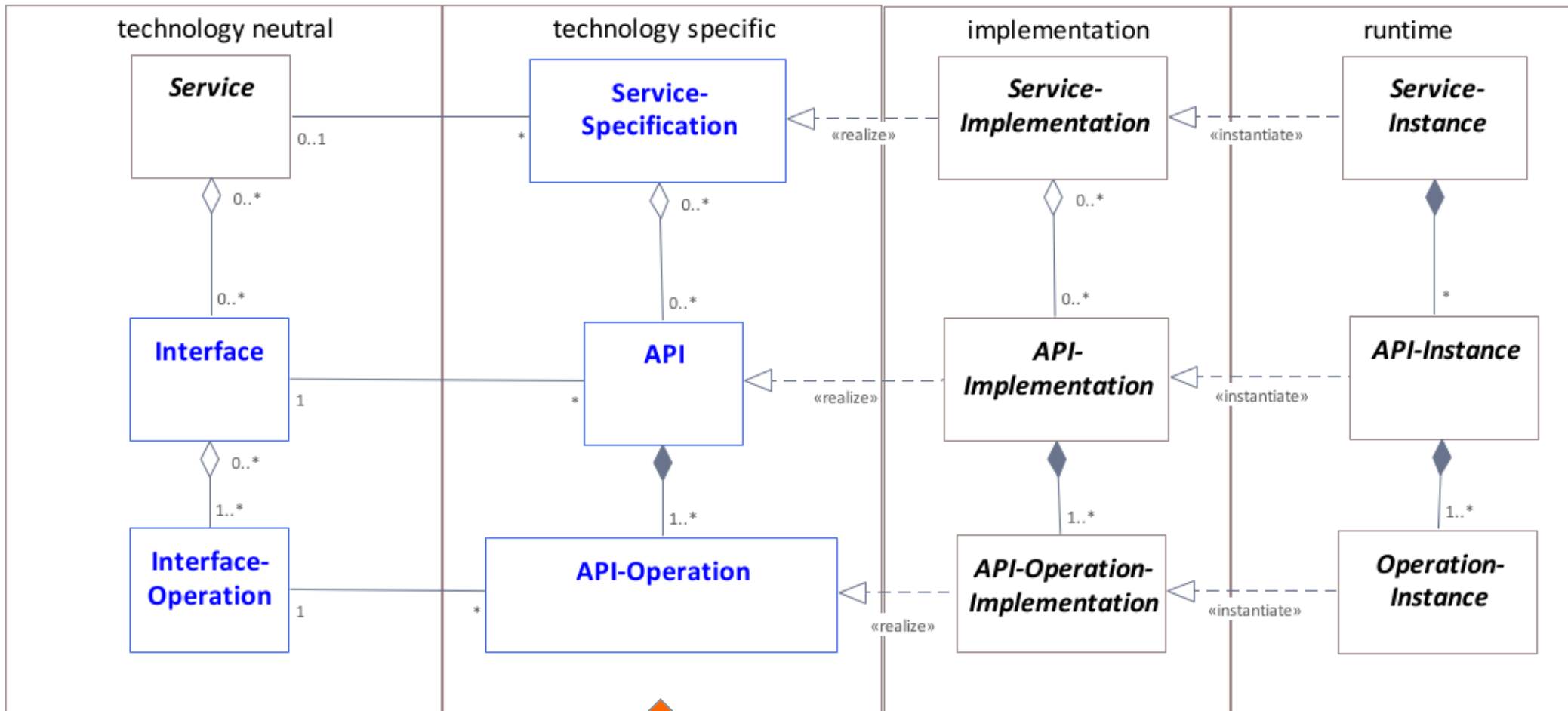
- URL based versioning
- URL includes **/api/v<MAJOR>.<MINOR>**
- <PATCH> is not included in the URL
- Release Candidates are not included in the URL
- Compatibility must be kept

- Further information on implemented profiles by /description API



Figure 4 - Generic URL Scheme for AAS API Versioning

Figure 2: Services, Interfaces & APIs and Operations

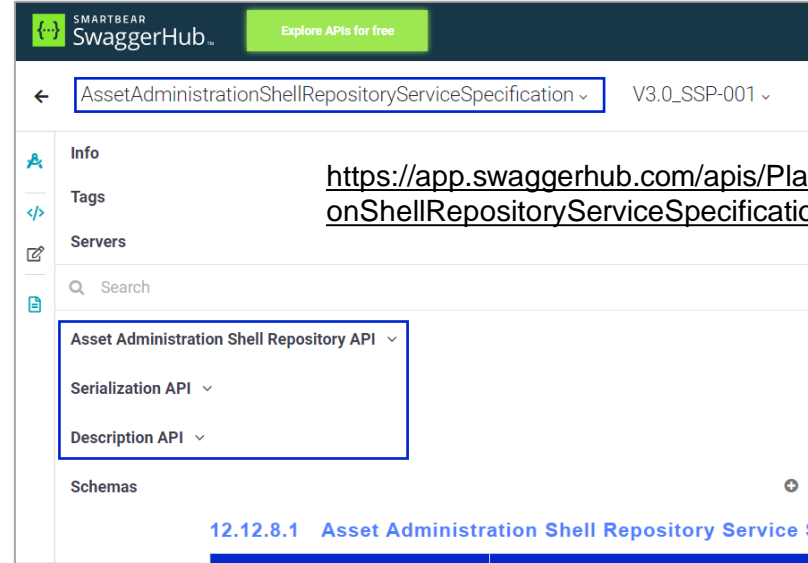


↑ REST API

Service Specifications and Profiles

Table 17 Overview of Service Specifications and the Contained APIs

Service Specifications:	Contained APIs:										
	Asset Administration Shell API	Submodel API	AASX File Server API	Asset Administration Shell Registry API	Submodel Registry API	Asset Administration Shell Repository API	Submodel Repository API	Concept Description Repository API	Asset Administration Shell Basic Discovery API	Serialization API	Description API
Asset Administration Shell Service Specification	X	S								X	X
Submodel Service Specification		X								X	X
AASX File Server Service Specification			X								X
Asset Administration Shell Registry Serv. Spec.				X	S						X
Submodel Registry Service Specification					X						X
Discovery Service Specification									X		X
Asset Administration Shell Repository Serv. Spec.	S	S				X	S			X	X
Submodel Repository Service Specification		S					X			X	X
ConceptDescription Repository Service Spec.								X		X	X



https://app.swaggerhub.com/apis/Plattform_i40/AssetAdministrationShellRepositoryServiceSpecification/V3.0_SSP-001

12.12.8.1 Asset Administration Shell Repository Service Specification – Full Profile

Name:	AAS Repository Full Profile
Profile Identifier:	https://admin-shell.io/aas/API/3/0/AssetAdministrationShellRepositoryServiceSpecification/SSP-001
Feature	Appearance

12.12.8.2 Asset Administration Shell Repository Service Specification – Read Profile

Name:	AAS Repository Read Profile
Profile Identifier:	https://admin-shell.io/aas/API/3/0/AssetAdministrationShellRepositoryServiceSpecification/SSP-002
Feature	Appearance



Description Interface



9.2 Operation GetSelfDescription

Operation Name	GetSelfDescription			
Explanation	Returns a description object containing the capabilities and supported features of the server.			
semanticId	https://admin-shell.io/aas/API/GetSelfDescription/3/0			
Name	Description	Mand.	Type	Card.
Output Parameter				
statusCode	Status code	yes	StatusCode	1
description	Key-value-pairs that describe the capabilities of the providing server	yes	ServiceDescription	1

```

1843 /description:
1844 get:
1845 tags:
1846   - Description API
1847 summary: Returns the self-description of
1848 a network resource (ServiceDescription)
1849 operationId: GetDescription
1850 x-semanticIds:
1851   - https://admin-shell.io/aas/API/3/0/GetDescription/3/0
1852 responses:
1853   '200':
1854     description: Requested Description
1855     content:
1856       application/json:
1857         schema:
1858           $ref: 'https://api-registry.
  
```

```

685 ServiceDescription:
686 description: The Description object enables servers
687 to present their capabilities to the clients, in
688 particular which profiles they implement. At least
689 one defined profile is required. Additional,
690 proprietary attributes might be included.
691 Nevertheless, the server must not expect that a
692 regular client understands them.
693 example: >-
694 {
695   "profiles": [
696     "https://admin-shell.io/aas/API/3/0/AssetAdministrationShellRegistryServiceSpecification/SSP-002",
697     "https://admin-shell.io/aas/API/3/0/SubmodelRegistryServiceSpecification/SSP-002"
698   ]
699 }
700 properties:
701 profiles:
702   type: array
703   minItems: 1
704   items:
705     type: string
706     enum:
707       - "https://admin-shell.io/aas/API/3/0/AssetAdministrationShellServiceSpecification/SSP-001"
708       - "https://admin-shell.io/aas/API/3/0/AssetAdministrationShellServiceSpecification/SSP-002"
  
```

Example profile string:

<https://admin-shell.io/aas/API/3/0/AssetAdministrationShellServiceSpecification/SSP-001>

Patch Submodel



GET	/submodel
PUT	/submodel
PATCH	/submodel
GET	/submodel/\$metadata
PATCH	/submodel/\$metadata
GET	/submodel/\$value
PATCH	/submodel/\$value
GET	/submodel/\$reference
GET	/submodel/\$path
GET	/submodel/submodel-elements
POST	/submodel/submodel-elements
GET	/submodel/submodel-elements/\$metadata
GET	/submodel/submodel-elements/\$value
GET	/submodel/submodel-elements/\$reference
GET	/submodel/submodel-elements/\$path
GET	/submodel/submodel-elements/{idShortPath}
POST	/submodel/submodel-elements/{idShortPath}
PUT	/submodel/submodel-elements/{idShortPath}
PATCH	/submodel/submodel-elements/{idShortPath}
DELETE	/submodel/submodel-elements/{idShortPath}
GET	/submodel/submodel-elements/{idShortPath}/\$metadata
PATCH	/submodel/submodel-elements/{idShortPath}/\$metadata
GET	/submodel/submodel-elements/{idShortPath}/\$value
PATCH	/submodel/submodel-elements/{idShortPath}/\$value
GET	/submodel/submodel-elements/{idShortPath}/\$reference
GET	/submodel/submodel-elements/{idShortPath}/\$path
GET	/submodel/submodel-elements/{idShortPath}/attachment

- **PATCH /submodel**
The given content is overwritten or inserted into the submodel (normal JSON serialization)
- **PATCH /submodel/\$metadata**
The given content is overwritten or inserted into the metadata of the submodel (metadata JSON serialization)
- **PATCH /submodel/\$value**
The given content is overwritten or inserted into the values of the submodel (value JSON serialization)

- **PATCH /submodel/submodel-elements/{idShortPath}**
The given content is overwritten or inserted into the submodel elements (normal JSON serialization)
- **PATCH /submodel /submodel-elements/{idShortPath}/\$metadata**
The given content is overwritten or inserted into the metadata of the submodel elements (metadata JSON serialization)
- **PATCH /submodel /submodel-elements/{idShortPath}/\$value**
The given content is overwritten or inserted into the values of the submodel elements (value JSON serialization)

Example: ZVEI Product Carbon Footprint

2079.2 kg CO₂e as-built

Submodels:

Nameplate	BillOfMaterial	ProductCarbonFootprint	TechnicalData	tasks
FootprintInformationCombination1				
CO2eq in kg		2079.2		
LifeCyclePhase		Cradle-to-gate		
FootprintInformationCombination2				
FootprintInformationCombination3				
FootprintInformationModule1				
FootprintInformationModule2				
FootprintInformationModule3				

Further Information

Impressum

Disclaimer: The PCF calculations of the control cabinet are intended as examples for the technical proof of concept with no claim for accuracy / correctness since there

New version at Hanover Fair:

- AAS and submodels hosted at the suppliers - about 10 AAS Repositories
- Registry
- Security
- Live PCF calculation and viewer
- **Important Note: Uses V3RC02**

<https://pcf.dpp40-2-v2.industrialdigitaltwin.org/pcf2>



 Let's go!



Andreas Orzelski, Master Specialist Standardization, Industrie 4.0

- Industrial Digital Twin Association (IDTA)
 - Board
 - WG Open Technology, WS AAS, Task Force REST API, Task Force Security, WS Open Source
- AAS Open Source
 - AASX Package Explorer and AASX Server
- IEC WG 24 „Asset Administration Shell“ (IEC 63278)
- DKE K 931 "System Aspects of Automation"
 - DKE AK 931.0.14 "Smart Manufacturing and Industrie 4.0"
 - DKE AK 931.0.16 „Asset Administration Shell"

