IDTA 02008-1-1 Time Series Data

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SPECIFICATION

Submodel Template of the Asset Administration Shell

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2021-11-01	1.0	Used for development only. No official version published.
2023-03-01	1.1	Release of the official Submodel template published by IDTA.

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1 General

1.1 About this document

This document is a part of a specification series. Each part specifies the contents of a Submodel template for the Asset Administration Shell (AAS). The AAS is described in [1], [2], [3] and [6]. First exemplary Submodel contents were described in [4], while the actual format of this document was derived by the "Administration Shell in Practice" [5]. The format aims to be very concise, giving only minimal necessary information for applying a Submodel template, while leaving deeper descriptions and specification of concepts, structures and mapping to the respective documents [1] to [6].

1.2 Scope of the Submodel Template

In Industrie 4.0, the ubiquity of data sources and sensors and low costs of storage has resulted in increasing amounts of time series data being captured – not only during the operational phase of an asset. A time series is a series of data points in time order over a period of time. Time Series can represent raw data, but can also represent main characteristics, textual descriptions or events in a concise way. This Submodel template aims at an interoperable description of time series data in industrial automation for the complete asset lifecycle. The focus of this Submodel template is on the semantic information of time series data. The Submodel claims to integrate time series data within the AAS itself, but also from external data sources. Figure 1 shows the use cases, such as sensor data from real and virtual sensors, and their technical storage options inside or outside the AAS that were taken into account in the creation of this specification.

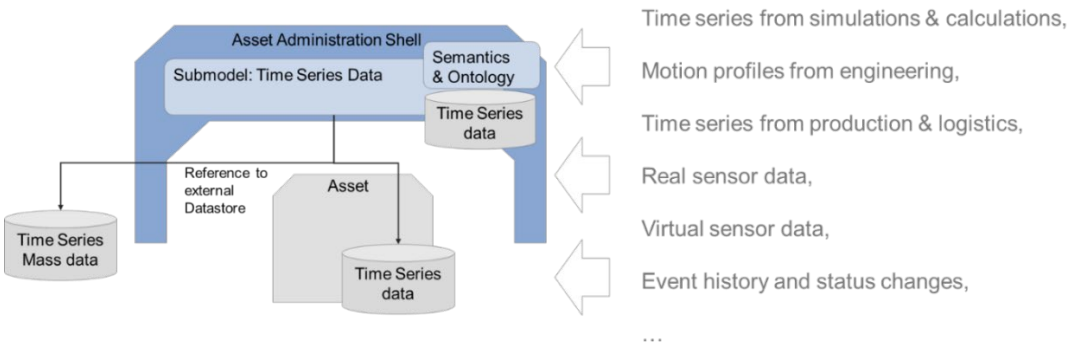


Figure 1 Scope and use cases for time series data

1.3 Relevant standards for the Submodel template

- ISO 8601 “Data elements and interchange formats – Information interchange – Representation of dates and times” was integrated for definition of time scales and time stamps
- JSON Time Series Format [7] was considered to add structure and metadata.
- ECLASS & IEC CDD was included to use semantic IDs for properties and qualifiers.
- ISO/IEC 18014-1:2008 Information technology -- Security techniques -- Time-stamping services is referenced to make a boundary with this specification regarding the time synchronization of various data sources.
- IEEE/IEC 61588-2021“Precision Clock Synchronization Protocol for Networked Measurement and Control Systems” [8] is referenced to make a boundary with this specification regarding the time synchronization of various data sources.
- OPC Foundation: OPC Unified Architecture Part 11“Historical Access” has been considered to provide the outlook on the methods for querying time series.

1.4 Use cases and requirements

In creating this specification, the following use cases were contributed by participants. General requirements were derived from the use cases and design decisions were made.

1.4.1 Time series data with passive AAS and passive Assets

The cold chain of an adhesive must be maintained from production to consumption. For this purpose, multiple distributed sensors monitor the ambient temperature and store this data in the AAS of the adhesive.

Regardless of whether the data is synchronized continuously or at specific time intervals, a consistent time series for the asset is available throughout the entire lifecycle and across different stakeholders. For this use case a passive AAS whithout computing capacity is sufficient.

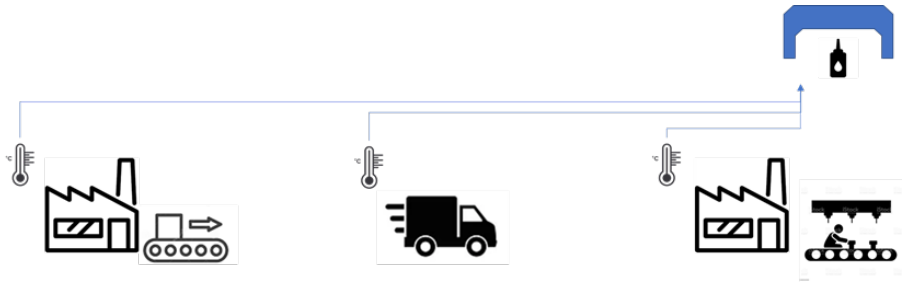


Figure 2 Use case of time series data along the value chain of an adhesive

1.4.2 Time Series Data within the engineering phase of an Asset

In the design of power drive systems, information on the motion sequence is exchanged between different partners. User defined timestamps (for instance acceleration time in seconds) are usually used to describe motion sequences. The following example shows a motion sequence of a rotary table in a sizing tool during the enginering phase of a machine.

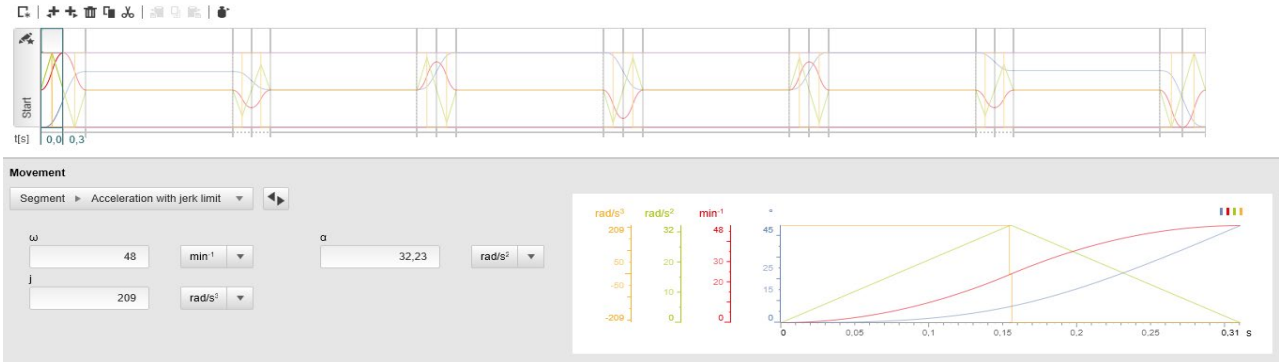


Figure 3 Use case of time series data in engineering – Motion Profiles

1.4.3 Time Series Data during usage phase – smart Sensor

This example gives an overview of how sensor telemetry data is stored in a file (e. g.CSV or BLOB in JSON Encoding). In this example a temperature Sensor and a 3-axis acceleration sensor was used to record a period of 5 seconds.

Tabelle 1: Use case of time series data during usage – smart sensor

Index	timestamp	Temperature (°C)	RMS of Acceleration x-axis (m/s^2)	RMS of Acceleration y-axis (m/s^2)	RMS of Acceleration z-axis (m/s^2)
0	2020-01-22T16:38:09Z	23.400	0.60	0.65	0.90
1	2020-01-22T16:38:10Z	23.415	0.61	0.80	1.00
2	2020-01-22T16:38:11Z	23.420	0.62	0.85	0.90
3	2020-01-22T16:38:12Z	23.405	1.60	5.00	1.25
4	2020-01-22T16:38:13Z	23.405	5.65	6.15	1.20
5	2020-01-22T16:38:14Z	23.390	6.00	6.50	2.05

If hundreds of different sensors are used on a factory floor, whose measurements are available locally, on-edge and in the cloud, for example, with different retention periods and integrity, a manufacturer- and technology-neutral semantic description is necessary. In addition, the requirement to support a variety of optimized and distributed storage options in the Submodel is obvious.

2 Submodel Template Time Series Data

2.1 Approach

This Submodel represents an approach for the semantic description of time series along the entire asset life cycle in the AAS. Since there are many optimized database systems for time series data, this specification defines the integration of external data sources, as well as the storage of time series in the AAS itself. In addition, the outlook on operations is given to enable standardized queries, inputs and functions on time series data.

Time Series Data throughout the asset lifecycle

The Time Series Data Submodel can cover different phases of a product life cycle. As shown in Figure 4, the usage of Time Series Data Submodel starts during the Engineering Phases (Development of a type). During this phase, the Template of Time Series Data Submodel is created based on the Metadata of the corresponding product “type”. The focus of the Time Series Data Submodel, however, is after the product is instantiated and starts to store the record data that the product is generating.

Note – an asset type can also have a Submodel-instance with type-related time series data containing segments and records, e. g. time series from simulations or calculations during the design phases.

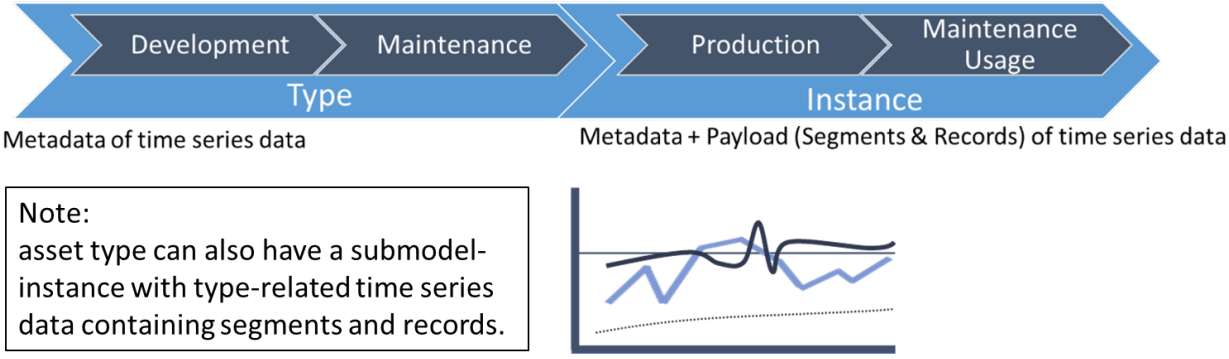


Figure 4 AAS Time Series Data Submodel within the product life cycle

Generic Structure of Time Series

A time series consists of data points in time order. Timestamped data is the most basic type of time series that associates values with points in time. An example of time series is shown in Table 2.

Tabelle 2: Simple time series

index	Timestamp	value
0	2020-01-22T16:38:09Z	4
1	2020-01-22T16:39:09Z	5
2	2020-01-22T16:40:00Z	2
3	2020-01-22T16:41:30Z	6
4	2020-01-22T16:45:20Z	4
5	2020-01-22T16:50:36Z	1

A **timestamp** is used to assign a time to a data point or event. **Data points** (variables) can be measurement data, events, or even textual descriptions. **Segments** (subsequences) of a time series divide a time series into logical sections, which can be labelled and be described by further semantics.

For an interoperable exchange of time series data **structure**, **timestamps**, **data points** and **operations** are defined in more detail in chapter 2.2. This specification focuses on these core elements of a time series.

Depending on the application and technology used, the times series model should be extended by further properties and qualifier.

2.2 Definitions within the Submodel template specification

2.2.1 Notions of Time

A timestamp is used to assign various events and data to a unique point in time. The ISO 8601 standard can be used for an unambiguous and well-defined method of presenting date, time of day, date and time, time intervals and recurring time intervals. For a common interpretation of the timestamp, it is also indicated with its time scale. In the automation and IT world, the Coordinated Universal Time (UTC) and the International Atomic Time (TAI) time scales are established and are therefore prefeared to use in this specification.
In contrast to these international specified time scales are relative time measurements - e.g., with a stopwatch - where the zero point can be arbitrary because of the mere measurement of a time difference. For these time series the ISO 8601 timestamp is not appropriate and user-defined time formats and values are used (see Figure 5).

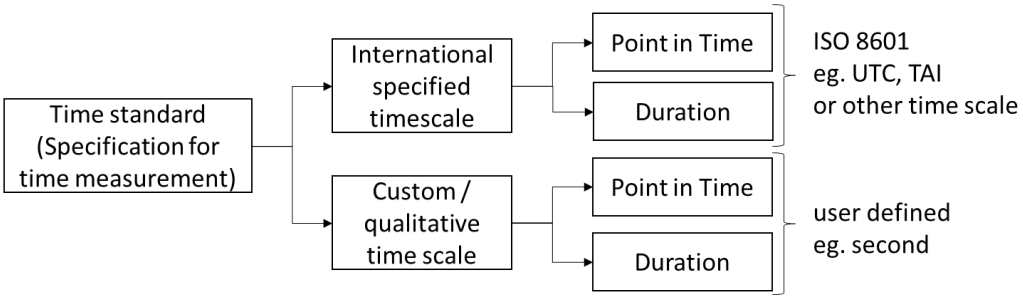


Figure 5 Classification of time specifications

To describe the timeline of a qualitative time scale, the time unit such as hours, minutes, seconds, milliseconds, or microseconds must be determined. Due to the SI (Système International) base unit, seconds are the preferred time unit in this specification. In addition, it must be determined whether these are time points or durations. A time point is one point on the time axis, whereas duration describe the length of a time interval. Time intervals are limited by two points in time.

Usually and if not explicitly stated, time points refer to the starting point of the time scale, whereas time durations build on each other (see Figure 6). To clearly identify the measurement model (absolute or incremental), this can be done via a qualifier.
Note – data points (variables) of a measurement series can also be absolute or incremental.

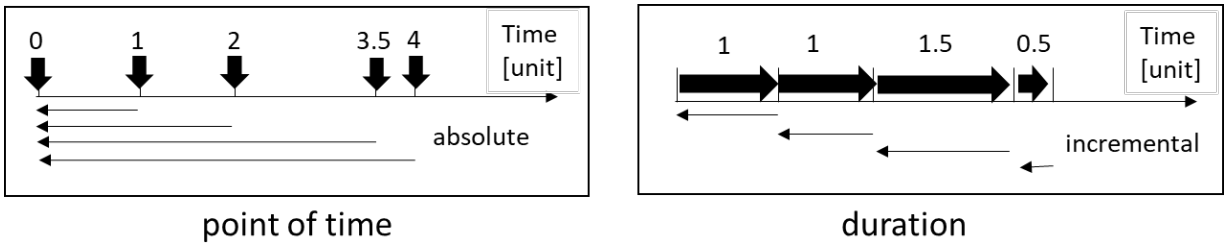


Figure 6 Example of absolute and incremental time points and durations within a user-defined time scale

Based on these explanations, the requirement for the following AAS Submodel Elements were determined:

- **Time** <<Property>> with its corresponding semantic ID for eg. TAI, UTC or custom time scales:
  - **UtcTime** <<ConceptDescription>>
  - **TaiTime** << ConceptDescription >>
  - **RelativePointInTime** << ConceptDescription >> in seconds, due to the SI base unit
  - **RelativeTimeDuration** << ConceptDescription >> in seconds, due to the SI base unit
- **MeasurementModelQualifier** <<Qualifier>> with value list [absolute, incremental]

Note – Other timestamp formats and scales, such as Unix Time, Ephemeris Time (ET) or Barycentric Dynamical Time (TBD) can be defined as Concept Description with corresponding semantic IDs.

Note – A time series can contain several timestamps, for example a timestamp from the sensor and a timestamp from superior instances or in different timescales.

Note – This specification does not address the synchronization of clocks in measurement and control systems. A time stamp produced by the clock of the local computer should be synchronized with a time stamp service provider, which is serving a common time reference. Further specifications such as IEC/IEEE 61588 “Precision Clock Synchronization Protocol for Networked Measurement and Control Systems” give guidance for this.

2.2.2 Data points and Segments

Data points (variables) can be measurement data, events, or even textual descriptions. A data point has several values X_1, X_2, X_3, X_n with correspondending units (e. g. °C, m/s², rpm, V, A, …). Depending on the number of data points, a time series can have simple or complex structures (e. g. $X_1, Y_1, Z_1, X_2, Y_2, Z_2, X_3, Y_3, Z_3, X_n, Y_n, Z_{n,}$).

This specification does not define semantic IDs of time series variables. The semantic IDs of the data points depend on the measured variables and their applications and should be chosen accordingly.

Record IDs - Within a time series timestamps and associated values are linked in a record via by an Identifier (ID). The record ID must be unique within a time series. For simple time series, the record ID could be handled like an index of integers and start with 0. For mass data and harmonizations from distributed data sources, the ID in the form of a GUID is more appropriate. An explicit property for the record ID can be omitted, if the idShort of the Submodel Element Collection is used as unique ID within a time series (see Figure 7).

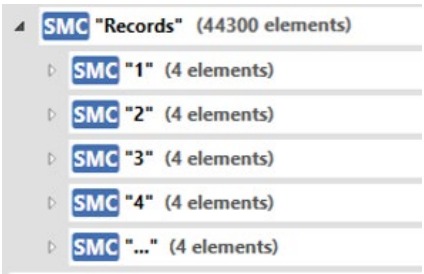


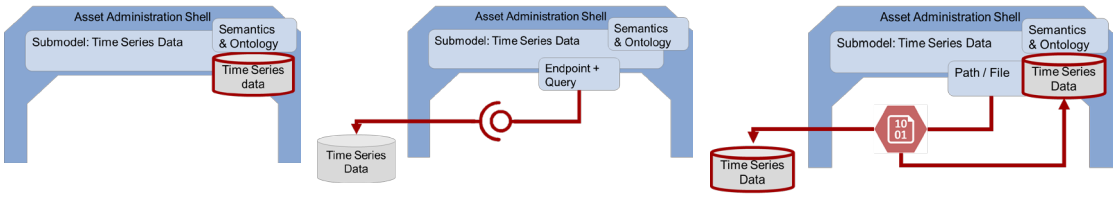
Figure 7 Element IdShort as unique ID of a time series record

A time series **segment** is a subsequence of values from the variables within a time series. Different techniques for segmentation during data processing and analysis can be used. A segment has a name, a description, the number of records, a start time, and an end time. Other information such as the sampling rate, the sampling interval or additional user-defined properties may be contained. In addition, the status of a time series segment can be important for users, in the meaning that the segment is completed (status = completed) or is still subject to ongoing changes (status = in progress). For this requirement, a last updated property can also be set.

Note - Sampling rate refers to the number of samples per second. It is usually measured in hertz (Hz) and is often expressed as a frequency. For example, a sampling rate of 44.1 kHz means that 44,100 samples are taken per second. The sampling interval refers to the time between successive records. It is usually measured in seconds and is the inverse of the sampling rate. For example, if the sampling rate is 44.1 kHz, the sampling interval is approximately 22.68 microseconds (1/44100 seconds).

This specification defines three types of time series segments (Internal, Linked and External), which can be used according to the requirements of the use cases. Table 1 provides an overview of these.

Table 1 Types of time series segments



	InternalSegment	LinkedSegment	ExternalSegment
Description	InternalSegments allow an I4.0 application (defined in [7]) to manage the Time Series Data structure and content directly in the AAS.	LinkedSegments allow an I4.0 application to read out the endpoint and query to an external system to manage time series without the AAS.	ExternalSegments allow an I4.0 application to find a data or BLOB file within which time series data is stored.
Suitable for	- Few data points - handover of data points - Permissions managed within the AAS	- Brownfield integration - Mass data - Permissions managed in external system - dynamic time series without continuous update of AAS	- Brownfield integration - Static time Series - Handover of time Series - Few accesses
Implications	- dynamic time series require continuous updating of the AAS	- I4.0 application must be able to work with endpoint and query - Data semantics and payload separated from each other	- I4.0 application must be able to handle different file formats - Data semantics and payload separated from each other

Qualifier (e. g. from ECLASS, IEC CDD or OPC UA) can be used to express further semantics in conjunction with a defined data element type or a defined data value. Therefore, Qualifier can be used in all those cases where existing definitions of data element types are not sufficiently specified.

Possible relevant qualifiers for time series data are:

- ValueQualityQualifier (IEC CDD 0112/2///61360_4#ADA350) [good, bad, uncertain]: The quality of the data values can be of value in a time series analysis. This allows bad data values to be omitted from aggregations or calculations.

- ValueOriginQualifier (IEC CDD 0112/2///61360_4#AAF582) [calculated, estimated, measured, set]: Information about the type of data collection or generation for the value provided.

- ValueProcessingQualifier (IEC CDD 0112/2///61360_4#AAF583#002) [arithmetic mean, median, root mean square, …]: Information about the method of preprocessing the value provided.

- MeasurementModelQualifier (defined in this Submodel specification) [absolute, incremental]: Information about whether there is an absolute measurement, or whether the value is to be seen as additive to the previous measurement.

Note - The scope of a qualifier depends on its application. For example, the ValueOriginQualifier can be applied to a single data element, to an entire record, or to the data element in the metadata collection.

2.2.3 AAS Modelling of Time Series

The preceding considerations and definitions are applied to the Time Series Submodel in Figure 8.

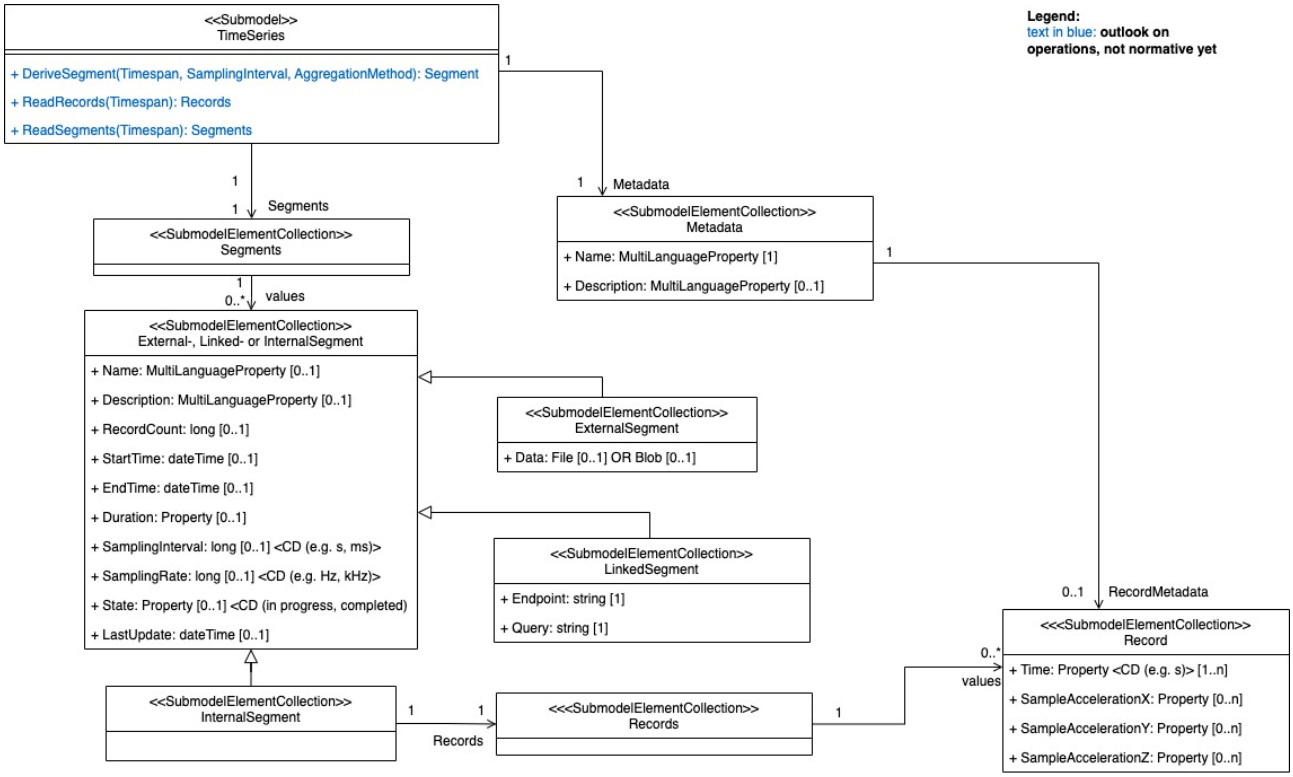


Figure 8 Time Series Data UML Diagram

2.3 Submodel Template of Time Series Data

Table 2 Specification of Submodel Template TimeSeries

idShort:	TimeSeries Note: the above idShort shall always be as stated.		
Class:	Submodel		
semanticId:	[IRI] https://admin-shell.io/idta/TimeSeries/1/1		
Explanation:	@de: Enthält Zeitreihendaten und Referenzen auf Zeitreihendaten, um diese entlang des Asset Lebenszyklus aufzufinden und semantisch zu beschreiben. @en: Contains time series data and references to time series data to discover and semantically describe them along the asset lifecycle.		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[SMC] Metadata	[IRI] https://admin-shell.io/idta/TimeSeries/Metadata/1/1 preferredName @de: Zeitreihen Metadaten preferredName @en: time series metadata definition @de: Eine Reihe von Daten, welche die Zeitreihe beschreiben und über sie Auskunft geben definition @en: A set of data describing and providing information about the time series	n/a	1
[SMC] Segments	[IRI] https://admin-shell.io/idta/TimeSeries/Segments/1/1 preferredName @de: Zeitreihensegmente preferredName @en: time series segments definition @de: Enthält Segmente einer Zeitreihe definition @en: Contains segments of a time series allowDuplicates = true	n/a	1

Note – see 2.6 “Outlook on Time Series Operations – not normative yet” for further SMEs in TimeSeries Submodel

Table 3 Specification of SMC Metadata

idShort:	Metadata Note: the above idShort shall always be as stated.		
Class:	SubmodelElementCollection (SMC)		
semanticId:	[IRI] https://admin-shell.io/idta/TimeSeries/Metadata/1/1		
Parent:	Submodel TimeSeries.		
Explanation:	@de: Eine Reihe von Daten, welche die Zeitreihe beschreiben und über sie Auskunft geben @en: A set of data describing and providing information about the time series		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[MultiLanguageProperty] Name	[IRI] https://admin-shell.io/idta/TimeSeries/Metadata/Name/1/1 preferredName @de: Name des Zeitreihe preferredName @en: Name of the time series Definition @de: Aussagekräftiger Name zur Beschriftung Definition @en: Meaningful name for labeling	[STRING_TRANSLATABLE] IO-Link Sensor Data@en IO-Link Sensordaten@de	1
[MultiLanguageProperty] Description	[IRI] https://admin-shell.io/idta/TimeSeries/Metadata/Description/1/1 preferredName @de: Beschreibung der Zeitreihe preferredName @en: Description of the time series Definition @de: Kurze Beschreibung der Zeitreihendaten Definition @en: Short description of the time series	[STRING_TRANSLATABLE] IO-Link process data of the sensor@en IO-Link Prozessdaten des Sensors@de	0..1
[SMC] Record	[IRI] https://admin-shell.io/idta/TimeSeries/Record/1/1 preferredName @de: Zeitreihen-Datensatz preferredName @en: Time series record definition @de: Ein Zeitreihen-Datensatz ist durch seine ID innerhalb der Zeitreihe eindeutig und beinhaltet die auf die ID referenzierten Zeitstempel und Variablenwerte definition @en: A time series record is unique by its ID within the time series and contains the timestamps and variable values referenced to the ID ordered = true allowDuplicated = true	n/a	1

Table 4 Specification of SMC Record

idShort:	Record Note: a different idShort might be used, as long as it is unique in the Submodel.		
Class:	SubmodelElementCollection (SMC)		
semanticId:	[IRI] https://admin-shell.io/idta/TimeSeries/Record/1/1		
Parent:	SMC Metadata, SMC Records		
Explanation:	@de: Ein Zeitreihen-Datensatz ist durch seine ID innerhalb der Zeitreihe eindeutig und beinhaltet die auf die ID referenzierten Zeitstempel und Variablenwerte. Vergleichbar mit einer Zeile in einer Tabelle. @en: A time series record is unique by its ID within the time series and contains the timestamps and variable values referenced to the ID. Similar to a row in a table.		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[Property] Time{00}	[IRI] https://admin-shell.io/idta/TimeSeries/UtcTime/1/1 or [IRI] https://admin-shell.io/idta/TimeSeries/TaiTime/1/1 or [IRI] https://admin-shell.io/idta/TimeSeries/RelativePointInTime/1/1 or [IRI] https://admin-shell.io/idta/TimeSeries/RelativeTimeDuration/1/1 or other suitable semantic ID to select the appropriate time scale and time format. preferredName @de: Zeit preferredName @en: Time		1..n
{Variable}	Note: A suitable semantic ID should be used to select the appropriate variable definitions.	n/a	0..n

Table 5 Specification of SMC Segments

idShort:	Segments Note: the above idShort shall always be as stated.		
Class:	SubmodelElementCollection (SMC)		
semanticId:	[IRI] https://admin-shell.io/idta/TimeSeries/Segments/1/1		
Parent:	Submodel TimeSeries		
Explanation:	@de: Enthält Segmente einer Zeitreihe @en: Contains segments of a time series		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[SMC] ExternalSegment{00}	[IRI] https://admin-shell.io/idta/TimeSeries/Segments/ExternalSegment/1/1 preferredName @de: Externes Zeitreihensegment preferredName @en: external time series segment definition @de: Referenz auf eine Datei von Datenpunkten in aufeinanderfolgender Reihenfolge über einen bestimmten Zeitraum definition @en: Reference to a file of data points in sequential order over a period of time	n/a	0..n
[SMC] LinkedSegment{00}	[IRI] https://admin-shell.io/idta/TimeSeries/Segments/LinkedSegment/1/1 preferredName @de: Verknüpftes Zeitreihensegment preferredName @en: linked time series segment definition @de: Referenz auf einen Endpunkt von Datenpunkten in aufeinanderfolgender Reihenfolge über einen bestimmten Zeitraum definition @en: Reference to an endpoint of data points in sequential order over a period of time	n/a	0..n
[SMC] InternalSegment{00}	[IRI] https://admin-shell.io/idta/TimeSeries/Segments/InternalSegment/1/1 preferredName @de: Externes Zeitreihensegment preferredName @en: external time series segment definition @de: Gruppierte Abfolge von Datenpunkten in aufeinanderfolgender Reihenfolge über einen bestimmten Zeitraum definition @en: Grouped sequence of data points in sequential order over a specified period of time	n/a	0..n

Table 6 Specification of SMC InternalSegment

idShort:	InternalSegment Note: a different idShort might be used, as long as it is unique in the Submodel.		
Class:	SubmodelElementCollection (SMC)		
semanticId:	[IRI] https://admin-shell.io/idta/TimeSeries/Segments/InternalSegment/1/1		
Parent:	SMC Segments		
Explanation:	@de: Gruppierte abfolge von Datenpunkten in aufeinanderfolgender Reihenfolge über einen bestimmten Zeitraum @en: Grouped sequence of data points in successive order over a specified period of time		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[MultiLanguageProperty] Name	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/Name/1/1 preferredName @de: Name des Zeitreihensegments preferredName @en: Name of the time series segment Definition @en: Meaningful name for labeling Definition @de: Aussagekräftiger Name zur Beschriftung	[STRING_TRANSLATABLE] Regular operation@en Normalbetrieb@de	0..1
[MultiLanguageProperty] Description	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/Description/1/1 preferredName @de: Beschreibung des Zeitreihensegments preferredName @en: Description of the time series segment Definition @en: Short description of the time series segment Definition @de: Kurze Beschreibung des Zeitreihensegments	[STRING_TRANSLATABLE] IO-Link process data of the sensor during a normal motion@en IO-Link Prozessdaten des Sensors während einer Normalfahrt@de	0..1

[Property] RecordCount	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/RecordCount/1/1 preferredName @de: Anzahl der Datensätze preferredName @en: Record Count definition @de: Gibt an, wie viele Datensätze in einem Segment vorhanden sind definition @en: Indicates how many records are present in a segment	[LONG] 13134	0..1
[Property] StartTime	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/StartTime/1/1 or other meaningfull semantic id preferredName @de: Startzeit preferredName @en: Start time definition @de: Enthält den ersten aufgezeichneten Zeitstempel des Zeitreihensegments oder dessen Startzeitpunkt. Zeitformat und -skala entspricht dem der Zeitreihe. definition@en: Contains the first recorded timestamp of the time series segment or its start time if it is a qualitative time series. Time format and scale corresponds to that of the time series.	[TIMESTSAMP] 2020-09-19T14:40:38.318	0..1
[Property] EndTime	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/EndTime/1/1 or other meaningfull semantic id preferredName @de: Endzeit preferredName @en: End time definition @de: Enthält den letzten aufgezeichneten Zeitstempel des Zeitreihensegments oder dessen Ende. Zeitformat und -skala entspricht dem der Zeitreihe. definition@en: Contains the last recorded timestamp of the time series segment or its end. Time format and scale corresponds to that of the time series.	[TIMESTSAMP] 2020-09-19T14:40:38.318	0..1
[Property] Duration	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/Duration/1/1 or other meaningfull semantic id preferredName @de: Dauer preferredName @en: Duration definition @de: Zeitraum den das Segment umfasst, dargestellt nach ISO 8601 durch das Format P[n]Y[n]M[n]DT[n]H[n]M[n]S definition@en: Period covered by the segment, represented according to ISO 8601 by the format P[n]Y[n]M[n]DT[n]H[n]M[n]S	[String] P3DT4H59M (according to ISO 8601) or in case of other seamantic id [long] 14 [s]	0..1

[Property] SamplingInterval	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/SamplingInterval/1/1 Note: A different semantic ID is to be used to select the appropriate scale and format (eg. min, s, ms, …). preferredName @de: Abtastintervall preferredName @en: Sampling Interval definition @de: Der zeitliche Abstand zwischen zwei Datenpunkten (Länge eines Zyklus) definition @en: The time period between two time series records (Length of cycle)	[LONG] 1 s	0..1
[Property] SamplingRate	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/SamplingRate/1/1 Note: A different semantic ID is to be used to select the appropriate scale and format (eg. Hz, kHz, …). preferredName @de: Abtastrate preferredName @en: Sampling rate definition @de: Definiert die Anzahl der Abtastungen pro Sekunde für eine regelmäßige Zeitreihe in Hz. definition @en: Defines the number of samples per second for a regular time series in Hz.	[LONG] 3200 Hz	0..1
[Property] State	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/State/1/1 preferredName @de: Status preferredName @en: state definition @de: Zustand der Zeitreihe bezogen auf ihren Fortschritt definition @en: State of the time series related to its progress enumeration: in progress (https://admin-shell.io/idta/TimeSeries/Segment/State/InProgress/1/1), completed (https://admin-shell.io/idta/TimeSeries/Segment/State/Completed/1/1)	completed	0..1
[Property] LastUpdate	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/LastUpdate/1/1 preferredName @de: Letzte Aktualisierung preferredName @en: Last update definition @de: Zeitpunkt der letzten Veränderung definition @en: Time of the last chance	[TIMESTSAMP] 2020-09-19T14:40:38.318	0..1

[SMC] Records	[IRI] https://admin-shell.io/idta/TimeSeries/Records/1/1 preferredName @de: Zeitreihen-Datensätze preferredName @en: Time series records definition @de: Gruppe von Datenpunkten in aufeinanderfolgender Reihenfolge über einen bestimmten Zeitraum definition @en: Group of data points in successive order over a specified period of time ordered = true allowDuplicates = false	n/a	1

Table 7 Specification of SMC ExternalSegment

idShort:	ExternalSegment Note: a different idShort might be used, as long as it is unique in the Submodel.		
Class:	SubmodelElementCollection (SMC)		
semanticId:	[IRI] https://admin-shell.io/idta/TimeSeries/Segments/ExternalSegment/1/1		
Parent:	SMC Segments		
Explanation:	@de: Referenz auf eine Datei von Datenpunkten in aufeinanderfolgender Reihenfolge über einen bestimmten Zeitraum @en: Reference to a file of data points in sequential order over a period of time		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[MultiLanguageProperty] Name	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/Name/1/1 preferredName @de: Name des Zeitreihensegments preferredName @en: Name of the time series segment Definition @en: Meaningful name for labeling Definition @de: Aussagekräftiger Name zur Beschriftung	[STRING_TRANSLATABLE] Regular operation@en Normalbetrieb@de	0..1
[MultiLanguageProperty] Description	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/Description/1/1 preferredName @de: Beschreibung des Zeitreihensegments preferredName @en: Description of the time series segment Definition @en: Short description of the time series segment Definition @de: Kurze Beschreibung des Zeitreihensegments	[STRING_TRANSLATABLE] IO-Link process data of the sensor during a normal motion@en IO-Link Prozessdaten des Sensors während einer Normalfahrt@de	0..1

[Property] RecordCount	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/RecordCount/1/1 preferredName @de: Anzahl der Datensätze preferredName @en: Record Count definition @de: Gibt an, wie viele Datensätze in einem Segment vorhanden sind definition @en: Indicates how many records are present in a segment	[LONG] 13134	0..1
[Property] StartTime	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/StartTime/1/1 or other meaningfull semantic id preferredName @de: Startzeit preferredName @en: Start time definition @de: Enthält den ersten aufgezeichneten Zeitstempel des Zeitreihensegments oder dessen Startzeitpunkt. Zeitformat und -skala entspricht dem der Zeitreihe. definition@en: Contains the first recorded timestamp of the time series segment or its start time if it is a qualitative time series. Time format and scale corresponds to that of the time series.	[TIMESTSAMP] 2020-09-19T14:40:38.318	0..1
[Property] EndTime	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/EndTime/1/1 or other meaningfull semantic id preferredName @de: Endzeit preferredName @en: End time definition @de: Enthält den letzten aufgezeichneten Zeitstempel des Zeitreihensegments oder dessen Ende. Zeitformat und -skala entspricht dem der Zeitreihe. definition@en: Contains the last recorded timestamp of the time series segment or its end. Time format and scale corresponds to that of the time series.	[TIMESTSAMP] 2020-09-19T14:40:38.318	0..1
[Property] Duration	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/Duration/1/1 or other meaningfull semantic id preferredName @de: Dauer preferredName @en: Duration definition @de: Zeitraum den das Segment umfasst, dargestellt nach ISO 8601 durch das Format P[n]Y[n]M[n]DT[n]H[n]M[n]S definition@en: Period covered by the segment, represented according to ISO 8601 by the format P[n]Y[n]M[n]DT[n]H[n]M[n]S	[String] P3DT4H59M (according to ISO 8601) or in case of other seamantic id [long] 14 [s]	0..1

[Property] SamplingInterval	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/SamplingInterval/1/1 Note: A different semantic ID is to be used to select the appropriate scale and format (eg. min, s, ms, Hz, …). preferredName @de: Abtastintervall preferredName @en: Sampling Interval definition @de: Der zeitliche Abstand zwischen zwei Datenpunkten (Länge eines Zyklus) definition @en: The time period between two time series records (Length of cycle)	[LONG] 1 s	0..1
[Property] SamplingRate	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/SamplingRate/1/1 Note: A different semantic ID is to be used to select the appropriate scale and format (eg. min, s, ms, Hz, …). preferredName @de: Abtastrate preferredName @en: Sampling rate definition @de: Definiert die Anzahl der Abtastungen pro Sekunde für eine regelmäßige Zeitreihe in Hz. definition @en: Defines the number of samples per second for a regular time series in Hz.	[LONG] 3200 Hz	0..1
[Property] State	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/State/1/1 preferredName @de: Status preferredName @en: state definition @de: Zustand der Zeitreihe bezogen auf ihren Fortschritt definition @en: State of the time series related to its progress enumeration: in progress (https://admin-shell.io/idta/TimeSeries/Segment/State/InProgress/1/1), completed (https://admin-shell.io/idta/TimeSeries/Segment/State/Completed/1/1)	completed	0..1
[Property] LastUpdate	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/LastUpdate/1/1 preferredName @de: Letzte Aktualisierung preferredName @en: Last update definition @de: Zeitpunkt der letzten Veränderung definition @en: Time of the last chance	[TIMESTSAMP] 2020-09-19T14:40:38.318	0..1

[File] File	[IRI] https://admin-shell.io/idta/TimeSeries/File/1/1 preferredName @de: Zeitreihen Datendatei preferredName @en: time series data file definition @de: Abfolge von Datenpunkten in aufeinanderfolgender Reihenfolge über einen bestimmten Zeitraum innerhalb eines ausgelagerten Datenfiles definition @en: Sequence of data points in sequential order over a period of time within a paged data file	n/a	0..1
[Blob] Blob	[IRI] https://admin-shell.io/idta/TimeSeries/Blob/1/1 preferredName @de: Zeitreihen Blob preferredName @en: time series Blob definition @de: Abfolge von Datenpunkten in aufeinanderfolgender Reihenfolge über einen bestimmten Zeitraum innerhalb eines BLOBs definition @en: Sequence of data points in sequential order over a period of time within a BLOB	n/a	0..1

Table 8 Specification of SMC LinkedSegment

idShort:	LinkedSegment Note: a different idShort might be used, as long as it is unique in the Submodel.		
Class:	SubmodelElementCollection (SMC)		
semanticId:	[IRI] https://admin-shell.io/idta/TimeSeries/Segments/LinkedSegment/1/1		
Parent:	SMC Segments		
Explanation:	@de: Referenz auf einen Endpunkt von Datenpunkten in aufeinanderfolgender Reihenfolge über einen bestimmten Zeitraum @en: Reference to an endpoint of data points in sequential order over a period of time		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[MultiLanguageProperty] Name	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/Name/1/1 preferredName @de: Name des Zeitreihensegments preferredName @en: Name of the time series segment Definition @en: Meaningful name for labeling Definition @de: Aussagekräftiger Name zur Beschriftung	[STRING_TRANSLATABLE] Regular operation@en Normalbetrieb@de	0..1

[MultiLanguageProperty] Description	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/Description/1/1 preferredName @de: Beschreibung des Zeitreihensegments preferredName @en: Description of the time series segment Definition @en: Short description of the time series segment Definition @de: Kurze Beschreibung des Zeitreihensegments	[STRING_TRANSLATABLE] IO-Link process data of the sensor during a normal motion@en IO-Link Prozessdaten des Sensors während einer Normalfahrt@de	0..1
[Property] RecordCount	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/RecordCount/1/1 preferredName @de: Anzahl der Datensätze preferredName @en: Record Count definition @de: Gibt an, wie viele Datensätze in einem Segment vorhanden sind definition @en: Indicates how many records are present in a segment	[LONG] 13134	0..1
[Property] StartTime	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/StartTime/1/1 or other meaningfull semantic id preferredName @de: Startzeit preferredName @en: Start time definition @de: Enthält den ersten aufgezeichneten Zeitstempel des Zeitreihensegments oder dessen Startzeitpunkt. Zeitformat und -skala entspricht dem der Zeitreihe. definition@en: Contains the first recorded timestamp of the time series segment or its start time if it is a qualitative time series. Time format and scale corresponds to that of the time series.	[TIMESTSAMP] 2020-09-19T14:40:38.318	0..1
[Property] EndTime	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/EndTime/1/1 or other meaningfull semantic id preferredName @de: Endzeit preferredName @en: End time definition @de: Enthält den letzten aufgezeichneten Zeitstempel des Zeitreihensegments oder dessen Ende. Zeitformat und -skala entspricht dem der Zeitreihe. definition@en: Contains the last recorded timestamp of the time series segment or its end. Time format and scale corresponds to that of the time series.	[TIMESTSAMP] 2020-09-19T14:40:38.318	0..1

[Property] Duration	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/Duration/1/1 or other meaningfull semantic id preferredName @de: Dauer preferredName @en: Duration definition @de: Zeitraum den das Segment umfasst, dargestellt nach ISO 8601 durch das Format P[n]Y[n]M[n]DT[n]H[n]M[n]S definition@en: Period covered by the segment, represented according to ISO 8601 by the format P[n]Y[n]M[n]DT[n]H[n]M[n]S	[String] P3DT4H59M (According to ISO 8601) or in case of other seamantic id [long] 14 [s]	0..1
[Property] SamplingInterval	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/SamplingInterval/1/1 Note: A different semantic ID is to be used to select the appropriate scale and format (eg. min, s, ms, Hz, …). preferredName @de: Abtastintervall preferredName @en: Sampling Interval definition @de: Der zeitliche Abstand zwischen zwei Datenpunkten (Länge eines Zyklus) definition @en: The time period between two time series records (Length of cycle)	[LONG] 1 s	0..1
[Property] SamplingRate	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/SamplingRate/1/1 Note: A different semantic ID is to be used to select the appropriate scale and format (eg. min, s, ms, Hz, …). preferredName @de: Abtastrate preferredName @en: Sampling rate definition @de: Definiert die Anzahl der Abtastungen pro Sekunde für eine regelmäßige Zeitreihe in Hz. definition @en: Defines the number of samples per second for a regular time series in Hz.	[LONG] 3200 Hz	0..1
[Property] State	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/State/1/1 preferredName @de: Status preferredName @en: state definition @de: Zustand der Zeitreihe bezogen auf ihren Fortschritt definition @en: State of the time series related to its progress enumeration: in progress (https://admin-shell.io/idta/TimeSeries/Segment/State/InProgress/1/1), completed (https://admin-shell.io/idta/TimeSeries/Segment/State/Completed/1/1)	completed	0..1

[Property] LastUpdate	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/LastUpdate/1/1 preferredName @de: Letzte Aktualisierung preferredName @en: Last update definition @de: Zeitpunkt der letzten Veränderung definition @en: Time of the last chance	[TIMESTSAMP] 2020-09-19T14:40:38.318	0..1
[Property] Endpoint	[IRI] https://admin-shell.io/idta/TimeSeries/Endpoint/1/1 preferredName @de: Zeitreihen API Endpunkt preferredName @en: time series API endpoint definition @de: Gibt einen Standort einer Ressource auf einen API-Server an, über den Zeitreihen angefragt werden können definition @en: Specifies a location of a resource on an API server through which time series can be requested	n/a	1
[Property] Query	[IRI] https://admin-shell.io/idta/TimeSeries/Query/1/1 preferredName @de: Zeitreihen API Query preferredName @en: time series API Query definition @de: generische Abfrage zum Lesen von Zeitreihen-Daten aus einer API definition @en: generic query component to read time series data from an API	n/a	1

Table 9 Specification of SMC Records

idShort:	Records Note: the above idShort shall always be as stated.		
Class:	SubmodelElementCollection (SMC)		
semanticId:	[IRI] https://admin-shell.io/idta/TimeSeries/Records/1/1		
Parent:	SMC Segment		
Explanation:	@de: Gruppe von Datenpunkten in aufeinanderfolgender Reihenfolge über einen bestimmten Zeitraum @en: Group of data points in successive order over a specified period of time		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[SMC] Record	[IRI] https://admin-shell.io/idta/TimeSeries/Record/1/1 preferredName @de: Zeitreihen-Datensatz preferredName @en: Time series record Note: a different idShort should be chosen to be unique in the InternalRecord SMC. The idShort corresponds to the Record Id and can be a GUID or incremented. Ordered = true AllowDuplicates = true	n/a	0..n

2.4 Example Timestamp definitions

Table 10 Example Timestamp definitions

[SME type]	semanticId = [idType]value	[valueType]
idShort	**Description@en**	**example**
[Property] UtcTime	[IRI] https://admin-shell.io/idta/TimeSeries/UtcTime/1/1 or [IRDI] 0112/2///61360_4#ADA387#001 preferredName @de: Zeitstempel UTC preferredName @en: Timestamp UTC definition @de: Zeitstempel nach ISO 8601 auf der Zeitskala der koordinierten Weltzeit (UTC). definition@en: Timestamp according to ISO 8601 on the timescale ccordinated universal time (UTC).	[TIMESTSAMP] 2020-09-19T14:40:38.318
[Property] TaiTime	[IRI] https://admin-shell.io/idta/TimeSeries/TaiTime/1/1 or [IRDI] 0112/2///61360_4#ADA386#001 preferredName @de: Zeitstempel TAI preferredName @en: Timestamp TAI definition @de: Zeitstempel nach ISO 8601 auf der Zeitskala internationale Atomzeit (TAI). definition@en: Timestamp according to ISO 8601 on the timescale international atomic time (TAI).	[TIMESTSAMP] 2020-09-19T14:40:38.318
[Property] RelativeTimePoint	[IRI] https://admin-shell.io/idta/TimeSeries/RelativeTimePoint/1/1 preferredName @de: Zeitstempel preferredName @en: Timestamp definition @de: Zeitpunktangabe in Sekunden. Zeitpunkte referenzieren auf die Startzeit des Zeitreihensegments. definition@en: Point of Time in seconds. Time points refer to the start time of the time series segment.	[REAL_MEASURE] 5 s
[Property] RelativeTimeDuration	[IRI] [IRI] https://admin-shell.io/idta/TimeSeries/RelativeTimeDuration/1/1 or [IRDI] 0112/2///61360_4#AAE028#001 preferredName @de: Zeitdauer preferredName @en: Timeduration definition @de: Angabe der zeitlichen Dauer in Sekunden (Anzahl der Sekunden). Zeitdauern referenzieren auf den jeweils vorangegangenen Eintrag im Zeitreihensegment. definition@en: Time duration specification in seconds (number of seconds). Time durations refer to the previous entry in the time series segment.	[REAL_MEASURE] 5 s

2.5 Example qualifiers

Table 11 Example qualifiers

Qualifier/type	Qualifier/semanticId Description@en	Qualifier/value
ValueQualityQualifier	[IRDI] 0112/2///61360_4#ADA350 qualifier that specifies the quality of the value of a data element type Notice - The quality of the data values can be of value in a time series analysis. This allows bad data values to be omitted from aggregations or calculations.	0112/2///61360_7#CTA052 - good 0112/2///61360_7#CTA053 - bad 0112/2///61360_7#CTA054 - uncertain 0112/2///61360_7#CTA000 - others
ValueOriginQualifier	[IRDI] 0112/2///61360_4#AAF582 qualifier that specifies the type of data capturing or generation for the provided value Notice - Information about the type of data collection or generation for the value provided.	0112/2///61360_7#CTA004 - calculated 0112/2///61360_7#CTA005 - estimated 0112/2///61360_7#CTA006 - measured 0112/2///61360_7#CTA007 - set 0112/2///61360_7#CTA000 - others
ValueProcessingQualifier	[IRDI] 0112/2///61360_4#AAF583#002qualifier that specifies a method of selecting or computing a representative value from more than one valueNotice - Information about the method of preprocessing the value provided.	0112/2///61360_7#CTA008 - arithmetic mean 0112/2///61360_7#CTA009 - geometric mean 0112/2///61360_7#CTA010 - harmonic mean 0112/2///61360_7#CTA011 - median 0112/2///61360_7#CTA012 - mode 0112/2///61360_7#CTA013 - root mean square 0112/2///61360_7#CTA014 - weighted arithmetic mean 0112/2///61360_7#CTA015 - weighted geometric mean 0112/2///61360_7#CTA000 - others
[Qualifier] MeasurementModelQualifier	[IRI] https://admin-shell.io/idta/TimeSeries/Qualifier/MeasurementModel/1/1 qualifier that specifies whether there is an absolute measurement, or whether the value is to be seen as additive to the previous measurement Notice - Information about whether there is an absolute measurement, or it must be considered additive.	https://admin-shell.io/idta/TimeSeries/Qualifier/MeasurementModel/Absolute/1/1 - absolute https://admin-shell.io/idta/TimeSeries/Qualifier/MeasurementModel/Incremental/1/1 - incremental

2.6 Outlook on Time Series Operations – not normative yet

The defined Submodel offers more flexibility due to the different modeling approaches for time series segments, but this can lead to limitations in interoperability. I4.0 applications (defined in [7]) that access time series data may have to deal with proprietary systems and data formats (Figure 9).

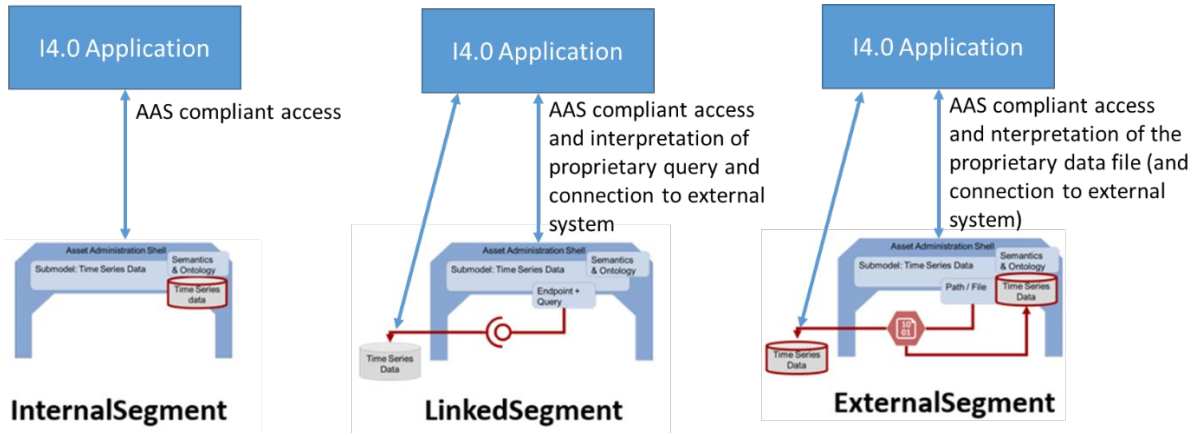


Figure 9 Data access without operations

Asset Administration Shells and Submodels offer Operations to specify a generic way to describe functional interfaces. This allows implementations of the AAS/SM to provide, as in this case, convenience operations or additional business functionality.

In our case we would like to simplify the identification of the data of interest:

- ReadSegments, ReadRecords provide access to physically existing data by filtering Segments / Records by time range.
- DeriveSegment perform additional computation by rearranging / aggregating existing data to meet the use case needs.

Since Operations may operate in many Segments, we decided to model them directly on the entry point of the time series Submodel. This additionally simplifies access since no navigation to child elements is required. Implementations should hide the complexity of combining data from different source aka. Segment types (Internal, Linked, External).

This approach enables I4.0 applications to access Time Series Data interoperably, regardless of storage location and format. However, the mapping and access must be programmed in the AAS for this (see Figure 10).

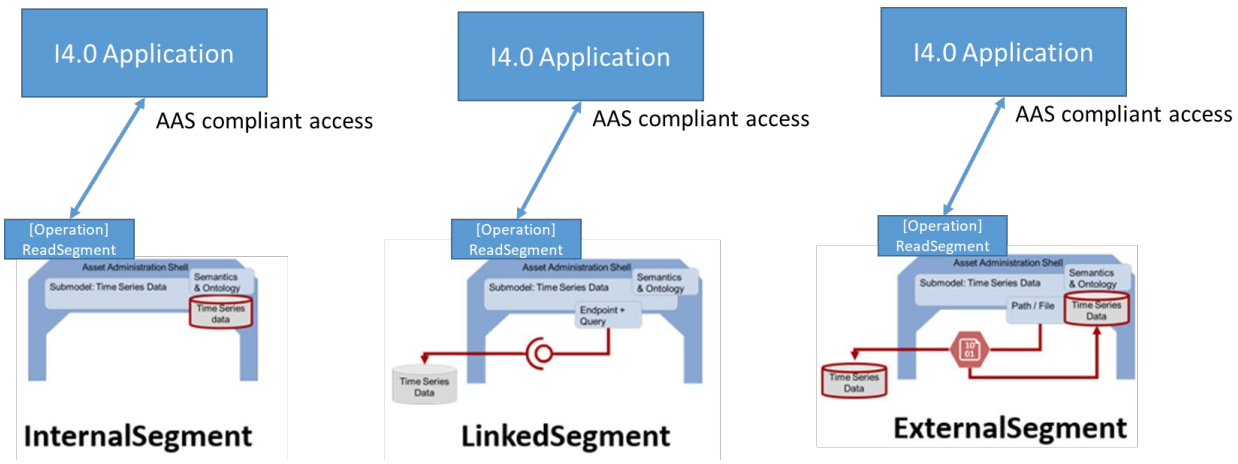


Figure 10 Data access with operations

Table 12 Outlook on Submodel Template TimeSeries with Operations

idShort:	TimeSeries Note: the above idShort shall always be as stated.		
Class:	Submodel		
semanticId:	[IRI] https://admin-shell.io/idta/TimeSeries/1/1		
Parent:			
Explanation:	@de: Enthält Zeitreihendaten und Referenzen auf Zeitreihendaten, um diese entlang des Asset Lebenszyklus aufzufinden und semantisch zu beschreiben. @en: Contains time series data and references to time series data to discover and semantically describe them along the asset lifecycle.		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[SMC] Metadata	[IRI] https://admin-shell.io/idta/TimeSeries/Metadata/1/1 preferredName @de: Zeitreihen Metadaten preferredName @en: time series metadata definition @de: Eine Reihe von Daten, welche die Zeitreihe beschreiben und über sie Auskunft geben definition @en: A set of data describing and providing information about the time series	n/a	1
[SMC] Segments	[IRI] https://admin-shell.io/idta/TimeSeries/Segments/1/1 preferredName @de: Zeitreihensegmente preferredName @en: time series segments definition @de: Enthält Segmente einer Zeitreihe definition @en: Contains segments of a time series	n/a	1
[Opr] DeriveSegments	[IRI] https://admin-shell.io/idta/TimeSeries/DeriveSegments/1/1	n/a	0..1
[Opr] ReadRecords	[IRI] https://admin-shell.io/idta/TimeSeries/ReadRecords/1/1	n/a	0..1
[Opr] ReadSegments	[IRI] https://admin-shell.io/idta/TimeSeries/ReadSegments/1/1	n/a	0..1

Table 13 Outlook on Operation DeriveSegment

idShort:	DeriveSegment Note: the above idShort shall always be as stated.
Class:	Operation
semanticId:	[IRI] https://admin-shell.io/idta/TimeSeries/DeriveSegment/1/1
Parent:	Submodel TimeSeries
Explanation:	@de: Berechnet ein Segment, das alle Datensätze aus allen Segmenten der angegebenen Zeitspanne enthält. Optional können die Datensätze auf verschiedene Arten aggregiert werden, um die Datenmenge zu reduzieren. @en: Computes a Segment containig all the Records from all Segments of the given timespan. Optionally, the Records can be aggregated in different ways to reduce the amount of data.

[Variable kind / Variable value type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[IN / Range] Timespan	[IRI] https://admin-shell.io/idta/TimeSeries/Timespan/1/1 preferredName @de: Zeitspanne preferredName @en: Timespan @de: Der valueType der übergebenen Zeitspanne muss mit dem valueType der Time Properties der Segemente übereinstimmen. @en: The valueType of the given timespan must match the valueType of the time properties of the segments.	n/a	1
[IN / Property] SamplingInterval	[IRI] https://admin-shell.io/idta/TimeSeries/Segment/SamplingInterval/1/1 Note: A different semantic ID is to be used to select the appropriate scale and format (eg. min, s, ms, Hz, …). preferredName @de: Abtastintervall preferredName @en: Sampling Interval definition @de: Der zeitliche Abstand zwischen zwei Datenpunkten (Länge eines Zyklus). definition @en: The time period between two time series records (Length of cycle).	long 5 Hz	0..1

[IN / Property] AggregationMethod	[IRI] https://admin-shell.io/idta/TimeSeries/AggregationMethod/1/1 @de: Methode zur Aggregation der Daten. Muss zusammen mit SampleInterval übergeben werden. @en: Method to aggregate data. Only valid in combination with SamplingInterval. Value List: - Max (Selects the largest data points) - Min (Selects the smallest data points) - Avg (Averages the data points) - Sum (Adds the data points together) - Count (The number of raw data points in the set) Note – for documentation and further value lists see http://opentsdb.net/docs/build/html/user_guide/query/aggregators.html		0..1
[OUT / SMC] Segment	[IRI] https://admin-shell.io/idta/TimeSeries/Segments/InternalSegment/1/1 Note – Record IDs must be unique across segments.	n/a	1

Table 14 Outlook on Operation ReadRecords

idShort:	ReadRecords Note: the above idShort shall always be as stated.		
Class:	Operation		
semanticId:	[IRI] https://admin-shell.io/idta/TimeSeries/ReadRecords/1/1		
Parent:	Submodel TimeSeries		
Explanation:	@de: Liefert alle Records über alle Segmente, die innerhalb der übergebenen Zeitspanne liegen. Etwaige Unterschiede bzgl. Abtastrate, Zeitintervallen, etc. werden nicht berücksichtigt. @en: Returns all records of all segments that are within the given time span. Any differences in sampling rate, time intervals, etc. are not considered.		
[Variable kind / Variable value type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[IN / Range] Timespan	[IRI] https://admin-shell.io/idta/TimeSeries/Timespan/1/1 preferredName @de: Zeitspanne preferredName @en: Timespan @de: Der valueType der übergebenen Zeitspanne muss mit dem valueType der Time Properties der Records übereinstimmen. @en: The valueType of the given timespan must match the valueType of the time properties of the Records.	n/a	1
[OUT / SMC] Records	[IRI] https://admin-shell.io/idta/TimeSeries/Records/1/1 @de: Records, die innerhalb der übergebenen Zeitspanne liegen. @en: Segments that overlap with the passed period.	n/a	0..*

Table 15 Outlook on Operation ReadSegments

idShort:	ReadSegments Note: the above idShort shall always be as stated.		
Class:	Operation		
semanticId:	[IRI] https://admin-shell.io/idta/TimeSeries/ReadSegments/1/1		
Parent:	Submodel TimeSeries		
Explanation:	@de: Liefert alle Segmente, deren Zeitspanne sich mit der übergebenen Periode überschneiden, ohne die enthaltenen Records zu filtern. Getroffene Segmente werden komplett zurückgegeben. @en: Returns all segments whose timespan overlaps the given period without filtering the records contained. Hit segments are returned in full.		
[Variable kind / Variable value type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[IN / Range] Timespan	[IRI] https://admin-shell.io/idta/TimeSeries/Timespan/1/1 preferredName @de: Zeitspanne preferredName @en: Timespan @de: Der valueType der übergebenen Zeitspanne muss mit dem valueType der Time Properties der Segemente übereinstimmen. @en: The valueType of the given timespan must match the valueType of the time properties of the Segments.	n/a	1
[OUT / SMC] Segments	[IRI] https://admin-shell.io/idta/TimeSeries/Segments/1/1 preferredName @de: Segments preferredName @en: Segments @de: Enthält Segmente, die sich zumindest teilweise mit der übergebenen Periode überschneiden. @en: Contains segments that at least partially overlap with the passed period.	n/a	0..*

Explanations on used table formats

1. General

The used tables in this document try to outline information as concise as possible. They do not convey all information on Submodels and SubmodelElements. For this purpose, the definitive definitions are given by a separate file in form of an AASX file of the Submodel template and its elements.

2. Tables on Submodels and SubmodelElements

For clarity and brevity, a set of rules is used for the tables for describing Submodels and SubmodelElements.

- The tables follow in principle the same conventions as in [5].
- The table heads abbreviate 'cardinality' with 'card'.
- The tables often place two information in different rows of the same table cell. In this case, the first information is marked out by sharp brackets [] form the second information. A special case are the semanticIds, which are marked out by the format: (type)(local)[idType]value.
- The types of SubmodelElements are abbreviated:

SME type	SubmodelElement type
Property	Property
MLP	MultiLanguageProperty
Range	Range
File	File
Blob	Blob
Ref	ReferenceElement
Rel	RelationshipElement
SMC	SubmodelElementCollection

- If an idShort ends with '{00}', this indicates a suffix of the respective length (here: 2) of decimal digits, in order to make the idShort unique. A different idShort might be choosen, as long as it is unique in the parent's context.
- The Keys of semanticId in the main section feature only idType and value, such as: [IRI]https://admin-shell.io/vdi/2770/1/0/DocumentId/Id. The attributes "type" and "local" (typically "ConceptDescription" and "(local)" or "GlobalReference" and (no-local)") need to be set accordingly; see [6].
- If a table does not contain a column with "parent" heading, all represented attributes share the same parent. This parent is denoted in the head of the table.
- Multi-language strings are represented by the text value, followed by '@'-character and the ISO 639 language code: example@EN.
- The [valueType] is only given for Properties.

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