TCCS SD1 - Data Model - ATO

SPT2TS-127386 - Disclaimer: The data model defined here is a DRAFT version, developed from bottom up inputs as per approaches defined in previous European projects, and from ongoing implementations in Innovation Pillar FPs. The content defined here shall not be considered as 'finalized' and is still a work in progress with the respective system pillar domains. **[**Content to be approved **]**

1 Table of Contents

2 Package "ATO"

2.1 Package Header

SPT2TS-122299 - {
"$schema": "ERJU meta-model.json",
"isDefinedBy": "http://ERJU/datamodel/0.4/ato",
"name": "AutomaticTrainOperation",
"containerStruct": "ATO",
"prefix": "ato",
"intId": 2,
"version": "1.0",
"info": "Data Model needed for ATO use case",
"structs": [], "enums": []
} **[** Open **]**

2.2 ATO

SPT2TS-63830 -

- **ATO (domain)** encapsulates several ATO-related static data like ATO Area, ATO Segment, and Segment Profile. It describes the content and configuration of Segment Profiles with respect to an ATO Area.
- **ATO Area** defines an ATO area containing 1..* ATO Segments confined to it.
- **ATO Segment** contains topological reference data (like start and end locations) for the segment profiles. Each ATO Segment contains one Segment profile.
- **Segment Profiles** are a set of static infrastructure data required by the ATO on-board to compute the Operational Speed Profile.

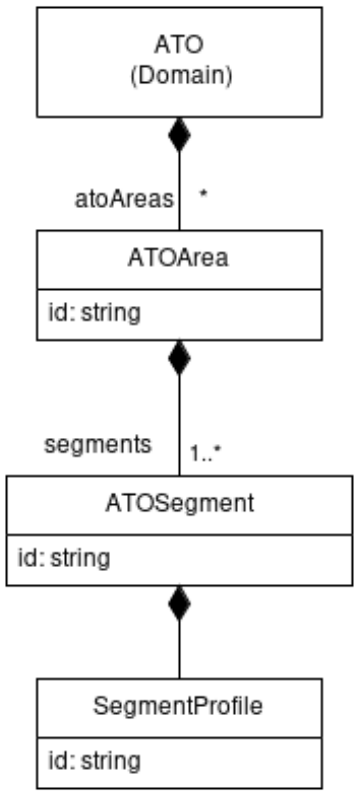

Figure 1 Class diagram ATO

[Content to be approved **]**

SPT2TS-48890 - ATO

```
{
   "structs":
[
{
```

```
  "name": "ATO",
  "attrs": [
    {"intId": 1, "name": "atoAreas", "composition": "ATOArea", "multiplicity": "*", "sortedByKey": true,
"info": "composes of ATO areas"}
  ]
},
{
    "name": "ATOArea",
    "info": "Defines ATO Area with collection of ATO segments with boarder of the infra.Area",
   "belongsToSubPackage": "ATOArea",
    "attrs": [
        {"intId": 1, "name": "id", "dataType": "string", "key": "global", "sameKeyAs": "infra.TopoArea",
 "info": "Identity of the object; used for referencing"},
        {"intId": 2, "name": "segments", "composition": "ATOSegment", "sortedByKey": true,
"multiplicity": "1..*", "info": "composes of segments"},
        {"intId": 3, "name": "timingPointsMapping", "composition": "TimingPointMapping",
"multiplicity": "*", "sortedByKey": true, "info": "composes of segments"}
]
}]
}
```


SPT2TS-125401 - TimingPointMapping


```
{
    "structs":
[
{
  "name": "TimingPointMapping",
  "info": "main Use-Case map from infra (timetable) to ato (journeyProfile)",
  "attrs": [
    {"intId": 1, "name": "infraTimingPoint", "reference": "infra.TimingPoint", "key": "global", "info":
"refers to infra timing point"},
    {"intId": 2, "name": "atoTimingPoint", "reference": "TimingPoint", "info": "refers to ato timing
point"}
  ]
}]
}
```


SPT2TS-125399 - ATOSegment


```
{
    "structs":
[
{
    "name": "ATOSegment",
```

```
    "info": "Defines the topology reference information for a segment profile.",
    "belongsToSubPackage": "ATOArea",
    "attrs": [
        {"intId": 1, "name": "id", "dataType": "string", "key": "global", "info": "Identity of the object; used for referencing"},
        {"intId": 2, "name": "dirTrackEdgeSection", "composition": "infra.DirTrackEdgeSection", "info": "composes of track edge sections"},
        {"intId": 3, "name": "segmentProfile", "composition": "SegmentProfile", "info": "composes of segment profiles"}
    ]
  }]
}
```


SPT2TS-125403 - SegmentProfile


```
{
    "structs":
[
  {
      "name": "SegmentProfile",
      "info": "Defines a segment profile for ATO",
      "belongsToSubPackage": "ATOArea",
      "attrs":[
        {"intId": 1, "name": "nidSP", "dataType": "uint32", "key": "local", "info": "defines national identifier for the segment profile"},
        {"intId": 2, "name": "segmentProfileLength", "dataType": "uint32", "unit": "m","exp": -2, "range": "1..16777216", "info": "the defined range corresponds to the constraints from SS126"},
        {"intId": 3, "name": "version", "dataType": "uint32", "info": "defines the version of the segment profile"},
        {"intId": 4, "name": "nid_c", "dataType": "uint32", "info": "defines country identifier for the segment profile"},
        {"intId": 5, "name": "eoaOffset", "dataType": "uint32", "unit": "m","exp": -2, "info": "defines EoA offset for the segment profile"},
        {"intId": 6, "name": "utcOffset", "dataType": "uint32", "unit": "minute", "info": "UTC time offset in minutes ; Resolution as defined in SS126 is 15 min"},
        {"intId": 7, "name": "startAltitude", "dataType": "int32", "unit": "m","exp": -2, "range": "-1000000..1048576", "info": "Altitude at the beginning of the SP. Considering ETRS89 as reference. The defined range corresponds to constraints from SS126"},
        {"intId": 8, "name": "atotsContactInfoDir", "dataType": "boolean", "info": "true if contact info exists for nominal direction ; false if contact info exists for reverse direction ; undefined if no contact info exists"},
        {"intId": 9, "name": "atotsContactInfo", "composition": "AtoTSContactInfo", "multiplicity":"0..1", "info": "Is only defined when 'atotsContactInfoDir' is true or false"},
        {"intId": 10, "name": "staticSpeedProfileStart", "composition": "StaticSpeedProfileStart", "inf
```

o": "composes of static speed profile"},
{"intId": 11, "name": "staticSpeedProfileChanges", "composition": "StaticSpeedProfileChange", "multiplicity":"*", "info": "composes of static speed profile changes"},
{"intId": 12, "name": "gradientStart", "dataType": "int32", "unit": "permill", "exp":-1, "info": "Required ATO Resolution is 0.1 permill; positiv: uphill, negative: downhill"},
{"intId": 13, "name": "gradientChanges", "composition": "GradientChange", "multiplicity":"0..32", "info": "composes of gradient changes"},
{"intId": 14, "name": "curveStart", "enumType": "CurveRadius", "info": "defines the curve radius at start of segment profile"},
{"intId": 15, "name": "curveChanges", "composition": "CurveChange", "multiplicity":"0..32", "info": "composes of curve changes"},
{"intId": 16, "name": "voltageStart", "composition": "VoltageStart", "info": "composes of voltage start"},
{"intId": 17, "name": "voltageChanges", "composition": "VoltageChange", "multiplicity":"0..32" , "info": "composes of voltage changes"},
{"intId": 18, "name": "currentStart", "dataType": "uint32", "unit": "A", "info": "Defined current limitation in Ampere ; Resolution as defined in SS126 = 10A"},
{"intId": 19, "name": "currentChanges", "composition": "CurrentChange", "multiplicity":"0..32", "info": "composes of current limitation changes"},
{"intId": 20, "name": "baliseGroups", "composition": "BaliseGroup", "multiplicity":"0..32", "info": "composes of balise groups"},
{"intId": 21, "name": "timingPoints", "composition": "TimingPoint", "multiplicity":"0..32", "info": "composes of timing points"},
{"intId": 22, "name": "platformAreas", "composition": "SegmentSection", "multiplicity": "0..32", "info": "composes of platform areas"},
{"intId": 23, "name": "tunnels", "composition": "Tunnel", "multiplicity":"0..32", "info": "composes of tunnels"},
{"intId": 24, "name": "axleLoadSpeedProfiles", "composition": "AxleLoadSpeedProfile", "multiplicity":"0..32", "info": "composes of axle load speed profiles"},
{"intId": 25, "name": "unprotectedLXs", "composition": "UnprotectedLX", "multiplicity": "0..32", "info": "composes of unprotected level crossings"},
{"intId": 26, "name": "permittedBrakingDistances", "composition": "PermittedBrakingDistance", "multiplicity":"0..32", "info": "composes of permitted braking distances"},
{"intId": 27, "name": "switchOffEddyCurrentBrakeServiceBrakes", "composition": "SegmentSection", "multiplicity":"0..32", "info": "composes of switch Off Eddy Current Brake Service Brakes"},
{"intId": 28, "name": "switchOffEddyCurrentBrakeEmergencyBrakes", "composition": "SegmentSection", "multiplicity":"0..32", "info": "composes of switch Off Eddy Emergency Brake Service Brakes"},
{"intId": 29, "name": "switchOffRegenerativeBrakes", "composition": "SegmentSection", "multiplicity":"0..32", "info": "composes of switch Off Regenerative Brakes"},
{"intId": 30, "name": "switchOffMagneticShoeBrakes", "composition": "SegmentSection", "

multiplicity":"0..32", "info": "composes of switch Off Magnetic Shoe Brakes"},
{"intId": 31, "name": "dynamicBrakeForceInhibitions", "composition": "SegmentSection", "multiplicity":"0..32", "info": "composes of Dynamic Brake Force Inhibitions"},
{"intId": 32, "name": "limitedDynamicBrakeForces", "composition": "LimitedDynamicBrakeForce", "multiplicity":"0..32", "info": "composes of Limited Dynamic Brake Forces"}
]
}]
}

SPT2TS-125404 - AtoTSContactInfo

{
"structs":
[
{
"name": "AtoTSContactInfo",
"info": "Defines the ATO-TS contact information for a segment profile",
"belongsToSubPackage": "ATOArea",
"attrs": [
{"intId": 1, "name": "nidATOTS", "dataType": "uint32", "info": "defines national identifier for the ATO-TS"},
{"intId": 2, "name": "nidSP", "dataType": "uint32", "info": "defines national identifier for the ATO-TS"},
{"intId": 3, "name": "spNidC", "dataType": "uint32", "info": "defines country identifier for the segment profile"},
{"intId": 4, "name": "atotsNidC", "dataType": "uint32", "info": "defines county identifier for the segment profile"}
]
}]
}

SPT2TS-125402 - StaticSpeedProfileStart

{
"structs":
[
{
"name": "StaticSpeedProfileStart",
"info": "Defines the static speed profile for a section of track",
"belongsToSubPackage": "functionalArea",
"attrs": [
{"intId": 1, "name": "speed", "dataType": "uint32", "unit": "km/h", "info": "Defines the applicable speed for the section of track ; Resolution as defined in SS126 = 5 km/h"},
{"intId": 2, "name": "specificStaticSpeedProfile", "composition": "infra.SpecificStaticSpeedLimit", "multiplicity": "0..*", "info": "composes of specific static speed profiles"},

{"intId": 3, "name": "trainEndApplicability", "enumType": "infra.TrainEndApplicability", "info": "Indicates if a speed limit given for a profile element is to be applied until the front of the train (no train length delay) or the end of the train (train length delay) has left the element."}
]
}]
}

SPT2TS-125405 - StaticSpeedProfileChange

{
"structs":
[
{
"name": "StaticSpeedProfileChange",
"info": "Defines the static speed profile for a section of track",
"belongsToSubPackage": "functionalArea",
"attrs": [
{"intId": 1, "name": "pos", "dataType": "uint32", "unit": "m","exp": -2, "info": "position on the associated segment profile"},
{"intId": 2, "name": "speed", "dataType": "uint32", "unit": "km/h", "info": "Defines the applicable speed for the section of track ; Resolution as defined in SS126 = 5 km/h"},
{"intId": 3, "name": "specificStaticSpeedProfile", "composition": "infra.SpecificStaticSpeedLimit", "multiplicity": "0..*", "info": "composes of specific static speed profiles"},
{"intId": 4, "name": "trainEndApplicability", "enumType": "infra.TrainEndApplicability", "info": "Indicates if a speed limit given for a profile element is to be applied until the front of the train (no train length delay) or the end of the train (train length delay) has left the element."}
]
}]
}

SPT2TS-125406 - AxleLoadSpeedProfile

{
"structs":
[
{
"name": "AxleLoadSpeedProfile",
"info": "Defines the axle load speed profile for a section of SegmentProfile",
"belongsToSubPackage": "functionalArea",
"attrs": [
{"intId": 1, "name": "segmentSection", "composition": "SegmentSection", "info": "composes of segment sections"},
{"intId": 2, "name": "speed", "dataType": "uint32", "unit": "km/h", "info": "Defines the applicable speed for the section of track ; Resolution as defined in SS126 = 5 km/h"},
{"intId": 3, "name": "trainEndApplicability", "enumType": "infra.TrainEndApplicability", "info": "

Indicates if a speed limit given for a profile element is to be applied until the front of the train (no train length delay) or the end of the train (train length delay) has left the element."},
{"intId": 4,"name": "axleLoadCategory", "enumType": "infra.AxleLoadCategory", "info": "value indicating the suitable Axle load category."}
]
}]
}

SPT2TS-125407 - GradientChange

{
"structs":
[
{
"name": "GradientChange",
"info": "Defines the gradient at a given location in segment profile",
"belongsToSubPackage": "ATOArea",
"attrs":
[
{"intId": 1, "name": "pos", "dataType": "uint32", "unit": "m","exp": -2, "info": "Position on the associated segment profile"},
{"intId": 2, "name": "gradientValue", "dataType": "int32", "unit": "permill", "exp":-1, "info": "Required ATO Resolution is 0.1 permill; positiv: uphill, negative: downhill"}
]
}]
}

SPT2TS-125408 - CurveChange

{
"structs":
[
{
"name": "CurveChange",
"info": "Defines the curve at a given location in segment profile",
"belongsToSubPackage": "ATOArea",
"attrs":
[
{"intId": 1, "name": "pos", "dataType": "uint32", "unit": "m","exp": -2, "info": "Position on the associated segment profile"},
{"intId": 2, "name": "curve", "enumType": "CurveRadius", "info": "defines curve radius"}
]
}]
}

SPT2TS-125410 - TimingPoint

```
{
   "structs":
[
{
   "name": "TimingPoint",
   "info": "Defines a fixed point on the infrastructure",
   "belongsToSubPackage": "ATOArea",
   "attrs":
   [
      {"intId": 1, "name": "nidTP", "dataType": "uint32", "key": "local", "info": "defines national identifier for the timing point"},
      {"intId": 2, "name": "name", "dataType": "string", "info": "User-friendly name, only if different from id"},
      {"intId": 3, "name": "pos", "dataType": "uint32", "unit": "m","exp": -2, "info": "Position on the associated segment profile"},
      {"intId": 4, "name": "stopLocationTolerance", "enumType": "StopLocationTolerance", "info": " Defines the required stopping tolerance for a Timing Point"},
      {"intId": 5, "name": "stoppingPointReachDistance", "enumType": "StopLocationTolerance", "info": "Defines the distance from a stopping point to consider it as reached"}
   ]
}]
}
```


SPT2TS-125412 - BaliseGroup


```
{
   "structs":
[
{
   "name": "BaliseGroup",
   "info": "Defines a technical device group on the railway trackbed",
   "belongsToSubPackage": "ATOArea",
   "attrs":[
      {"intId": 1, "name": "nid_bg", "dataType": "uint32", "info": "defines national identifier for the balise group"},
      {"intId": 2, "name": "balises", "composition": "Balise", "multiplicity":"1..8", "info":"Defines the balises within the balise group"},
      {"intId": 3, "name": "nidCQualifier", "dataType": "boolean", "info": "true if same NID_C as in segment profile is to be used; false if new country id is to be used for the balise"},
      {"intId": 4, "name": "nid_c", "dataType": "uint32", "multiplicity":"0..1", "info": "to be defined when countyIdQualifier is false ; defines the new NID_C for the balise group"}
   ]
}]
}
```

SPT2TS-125425 - Balise


```
{
   "structs":
[
{
   "name": "Balise",
   "info": "Defines a technical device on the railway trackbed",
   "belongsToSubPackage": "ATOArea",
   "attrs":[
      {"intId": 1, "name": "positionInGroup", "dataType": "uint32", "range":"0..7", "info": "Defines the position of a balise in a balise group"},
      {"intId": 2,"name": "pos", "dataType": "uint32", "unit": "m","exp": -2, "info": "Position on the associated segment profile"}
   ]
}]
}
```


SPT2TS-125414 - PermittedBrakingDistance


```
{
   "structs":
[
{
   "name": "PermittedBrakingDistance",
   "info": "Defines the permitted braking distance information for a segment profile",
   "belongsToSubPackage": "ATOArea",
   "attrs": [
      {"intId": 1, "name": "segmentSection", "composition": "SegmentSection", "info": "composes for segment sections"},
      {"intId": 2, "name": "value", "dataType": "uint32", "unit": "m","exp": -2, "info": "defines the permitted braking distance value"},
      {"intId": 3, "name": "byEmergencyBrake", "dataType": "boolean", "info": "true if Braking is to be achieved using Emergency brake ; false if braking is to be achieved by service brake"},
      {"intId": 4, "name": "gradientValue", "dataType": "int32", "unit": "permill", "exp": -1, "info": "defines gradient value to be used for permitted braking distance"}
   ]
}]
}
```


SPT2TS-125416 - VoltageStart


```
{
   "structs":
[
{
```

```
    "name": "VoltageStart",
     "info": "Defines the power voltage information for a segment profile",
     "belongsToSubPackage": "ATOArea",
    "attrs": [
       {"intId": 1, "name": "voltage", "enumType": "infra.VoltageType", "info": "defines the voltage
type"},
        {"intId": 2, "name": "nid_c", "dataType": "uint32", "info": "defines the country identifier for
voltage"}
    ]
  }]
}
```


SPT2TS-125418 - VoltageChange


```
{
    "structs":
[
{
    "name": "VoltageChange",
     "info": "Defines the power voltage information for a segment profile",
     "belongsToSubPackage": "ATOArea",
    "attrs": [
       {"intId": 1, "name": "pos", "dataType": "uint32", "unit": "m","exp": -2, "info": "Position on the
associated segment profile"},
        {"intId": 2, "name": "voltage", "enumType": "infra.VoltageType", "info": "defines the voltage
type"},
        {"intId": 3, "name": "nid_c", "dataType": "uint32", "info": "defines the country identifier for
voltage"}
    ]
  }]
}
```


SPT2TS-125417 - CurrentChange


```
{
    "structs":
[
 {
    "name": "CurrentChange",
     "info": "Defines the current limitation information for a segment profile",
     "belongsToSubPackage": "ATOArea",
    "attrs": [
       {"intId": 1, "name": "pos", "dataType": "uint32", "unit": "m","exp": -2, "info": "Position on the
associated segment profile"},
        {"intId": 2, "name": "current", "dataType": "uint32", "unit": "A", "info": "Defined current
```

limitation in Ampere ; Resolution as defined in SS126 = 10A"}
]
}]
}

SPT2TS-125415 - Tunnel

{
"structs":
[
{
"name": "Tunnel",
"info": "Defines the tunnel information for a segment profile",
"belongsToSubPackage": "ATOArea",
"attrs": [
{"intId": 1, "name": "segmentSection", "composition": "SegmentSection", "info": "composes of segment sections"},
{"intId": 2, "name": "tunnelType", "enumType": "TunnelType", "info": "defines the tunnel type"
}
]
}]
}

SPT2TS-125413 - UnprotectedLX

{
"structs":
[
{
"name": "UnprotectedLX",
"info": "Defines the unprotected LX information for a segment profile",
"belongsToSubPackage": "ATOArea",
"attrs": [
{"intId": 1, "name": "pNominal", "dataType": "uint32", "unit": "m","exp": -2, "info": "Position on the segment profile associated for nominal direction of Segment profile"},
{"intId": 2, "name": "pReverse", "dataType": "uint32", "unit": "m","exp": -2, "info": "Position on the segment profile associated for reverse direction of Segment profile"}
]
}]
}

SPT2TS-125411 - LimitedDynamicBrakeForce

{
"structs":
[
{

```
    "name": "LimitedDynamicBrakeForce",
    "info": "Defines the limited dynamic brake force information for a segment profile",
    "belongsToSubPackage": "ATOArea",
    "attrs": [
      {"intId": 1, "name": "segmentSection", "composition": "SegmentSection", "info": "composes of segment sections"},
      {"intId": 2, "name": "dynamicBrakeForceLimit", "dataType": "uint32", "unit": "N", "range": "0..3000", "info": "the defined range corresponds to the constraints from SS126"}
    ]
}]
}
```


SPT2TS-125409 - SegmentSection


```
{
    "structs":
[
{
    "name": "SegmentSection",
    "info": "Defines sections with start and end references for use in segment profile",
    "belongsToSubPackage": "ATOArea",
    "attrs": [
      {"intId": 1, "name": "range", "enumType": "RangeType", "info": "defines range type"},
      {"intId": 2, "name": "pStart", "dataType": "uint32", "unit": "m","exp": -2, "info": "Start Position on the segment profile"},
      {"intId": 3, "name": "pEnd", "dataType": "uint32", "unit": "m", "exp": -2, "info": "End Position on the segment profile"}
    ]
}]
}
```


SPT2TS-125423 - RangeType


```
{
"enums": [
{
    "name": "RangeType",
    "info":"List defining range types for segment profile",
    "enumLiterals": [
      {"intId": 0, "name": "rtStart", "info": "starts in a SP"},
      {"intId": 1, "name": "rtEnd", "info": "ends in a SP"},
      {"intId": 2, "name": "rtStartEnd", "info": "start and ends in a SP"},
      {"intId": 3, "name": "rtWholeSP", "info": "covers the entire SP"}
    ]
}]
```

}

SPT2TS-125422 - TunnelType

{
"enums": [
{
"name": "TunnelType",
"info":"List defining tunnel types for segment profile",
"enumLiterals": [
{"intId": 0, "name": "singleTrackTunnel", "info": "defines a single track tunnel"},
{"intId": 1, "name": "doubleTrackTunnel", "info": "defines a double track tunnel"},
{"intId": 2, "name": "wideCrossSectionTunnel", "info": "defines tunnel with more than two tracks"}
]
}]
}

SPT2TS-125421 - CurveRadius

{
"enums": [
{
"name": "CurveRadius",
"info":"List defining different curve radii for segment profile",
"enumLiterals": [
{"intId": 0, "name": "cr_R_7000", "info": "R>7000"},
{"intId": 1, "name": "cr_7000_4500", "info": "7000>=R>4500"},
{"intId": 2, "name": "cr_4500_2800", "info": "4500>=R>2800"},
{"intId": 3, "name": "cr_2800_2000", "info": "2800>=R>2000"},
{"intId": 4, "name": "cr_2000_1500", "info": "2000>=R>1500"},
{"intId": 5, "name": "cr_1500_1250", "info": "1500>=R>1250"},
{"intId": 6, "name": "cr_1250_1075", "info": "1250>=R>1075"},
{"intId": 7, "name": "cr_1075_925", "info": "1075>=R>925"},
{"intId": 8, "name": "cr_925_825", "info": "925>=R>825"},
{"intId": 9, "name": "cr_825_725", "info": "825>=R>725"},
{"intId": 10, "name": "cr_725_625", "info": "725>=R>625"},
{"intId": 11, "name": "cr_625_525", "info": "625>=R>525"},
{"intId": 12, "name": "cr_525_475", "info": "525>=R>475"},
{"intId": 13, "name": "cr_475_425", "info": "475>=R>425"},
{"intId": 14, "name": "cr_425_375", "info": "425>=R>375"},
{"intId": 15, "name": "cr_375_325", "info": "375>=R>325"},
{"intId": 16, "name": "cr_325_300", "info": "325>=R>300"},
{"intId": 17, "name": "cr_300_275", "info": "300>=R>275"},
{"intId": 18, "name": "cr_275_250", "info": "275>=R>250"},

{"intId": 19, "name": "cr_250_225", "info": "250>=R>225"},
{"intId": 20, "name": "cr_225_200", "info": "225>=R>200"},
{"intId": 21, "name": "cr_200_175", "info": "200>=R>175"},
{"intId": 22, "name": "cr_175_150", "info": "175>=R>150"},
{"intId": 23, "name": "cr_R_150", "info": "R=<150"}
]
}]
}

SPT2TS-125420 - StopLocationTolerance

{
"enums": [
{
"name": "StopLocationTolerance",
"info":"List defining different stop location tolerances for a timing point of type stopping point.
Warning: intId differ from SS126 by 1",
"enumLiterals": [
{"intId": 0, "name": "T_Undefined", "info": "tolerance is undefind"},
{"intId": 1, "name": "T_10cm", "info": "10cm tolerance"},
{"intId": 2, "name": "T_20cm", "info": "20cm tolerance"},
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