

OFFICIAL



Department
for Transport

Digital Traffic Regulation Orders

Data Model – User Guide

Release 3.2.1 – Version 1.0 (July 2024)



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Digital Traffic Regulation Orders

Data Model – User Guide

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1. Digital Traffic Regulation Orders

1.1. Introduction

As part of its ‘Future of Mobility: Urban Strategy’, the Department for Transport (DfT) is modernising the regulatory framework for Traffic Regulation Orders (TROs) (Traffic Management Orders in London) made under the Road Traffic Regulation Act 1984.

The new regulatory framework will, subject to necessary legislation coming into force, mandate that traffic authorities in England publish TROs as open data in a standardised and digital format that anyone can access, use and share. The standardised digital format will be based on the Digital TRO (D-TRO) Data Model that is described in this document. This data model is intended to be a free resource for all. This data model is candidate in nature and may be subject to change without notification.

Taking into account the needs arising from the UK Industrial Strategy and recognising the requirements that will emerge from the deployment of Connected and Automated Vehicles (CAVs) this data model provides an initial framework for how the data and information relating to TROs can be formed in the future. Availability of such a draft data model, when suitably tested, will support the move towards TROs being easily accessible to the public whether using apps or driving connected vehicles.

The Automated Vehicles Act 2024¹ (clause 93) provides statutory instruction for Traffic Regulation Authorities² to provide information on a defined set of Traffic Regulation Orders, in a specified manner and form, to be provided in accordance with a specified model, standard or set of specifications. These will be the D-TRO Data Specifications including the D-TRO Data Model, are expected to be specified under secondary legislation.

The content of this data model has been developed by Harrod Booth Consulting Ltd with grateful support from numerous organisations.

The report presents the data model candidate, Release 3.2.1. this version is (notionally) released 5-July-2024, for use in the D-TRO Service Beta which is foreseen to go live in August 2024.

1.2. About this document

This document outlines the data modelling concepts defined to help support the definition and exchange of information relating traffic regulations, particularly within the scope of Traffic Regulation Orders as specified under UK legislation (notably the Automated Vehicles Act 2024, clause 93).

As explained in the introductory sections of this document the D-TRO Data Model contained and described here is by its nature developmental and evolutionary. Users, developers and stakeholders are encouraged to review and use this model and provide feedback and any identified issues to DfT.

¹ [Automated Vehicles Act 2024 \(legislation.gov.uk\)](https://www.legislation.gov.uk/ukpga/2024/1/section/93)

² Clause 93(3) of the Automated Vehicle Act specifies (3) — “traffic regulation authority” means a person who has the power to make a traffic regulation measure.

Any user feedback can be provided:

- By direct comment on the D-TRO GitHub repository:
<https://github.com/Department-for-Transport-External/TRO-DD>
- By contact to the Department for Transport
Name: John Cooper
Telephone Number: 07825 864288
Email Address: john.cooper@dft.gov.uk

The existing informational content of the existing legacy TROs in the UK is diverse, rich, and in some cases somewhat incompatible with a more limited, regularised approach defined in this specification for digitising traffic regulations.

This candidate data model has been the subject of on-going development, validation and piloting. It is not expected to be error-free or covering the full spectrum of TROs – but it is expected to support the digital encoding of a significant majority of TROs.

This document is primarily intended to be read by technologists who are familiar with data modelling concepts, especially use of UML, as the contained diagrams are expressed in this notation format.

As this specification evolves it is expected that additional context material will be made available to support ease of access to key concepts and principles for non-technical readers.

1.3. TROs in context

TROs are UK legislative instruments used by highways authorities to implement changes on the road network. They are used for such diverse purposes as:

- managing the use of the road with measures such as parking restrictions and speed limits,
- allowing temporary closures for street parties and roadworks, and
- experimental changes.

The new **UK Industrial Strategy**³ has four Grand Challenges focused on global trends which will transform our future. One challenge is for the UK to become a world leader in shaping the Future of Mobility.

One of the **Future of Mobility**⁴ Initial Priorities is to provide a **regulatory framework** to ensure we continue to have one of the most open environments in the world for transport innovation.

Data is a key enabler for innovation. Exploring and encouraging the **use of data** to support more effective operation of our transport system is one of our early priorities for the Future of Mobility Grand Challenge.

The **Local Transport Data Discovery Report**⁵, commissioned by DfT in 2018, explored the transport data held by Local Authorities. Its key findings relating to TROs were that:

- TRO data is difficult and time consuming to access, clean and process,
- TRO data is not in a standardised, machine-readable format,
- TROs lack of a centralised point of reference,
- Private sector organisations are being forced to collect TRO data manually, and

³ <https://www.gov.uk/government/topical-events/the-uks-industrial-strategy>

⁴ <https://www.gov.uk/government/publications/future-of-mobility-urban-strategy>

⁵ <https://www.gov.uk/government/publications/local-transport-data-discovery-findings-and-recommendations>

- The current process for amending and implementing a TRO is labour intensive, time consuming, and costly.

The report recommended that the DfT sponsor data projects which encourage and foster better local authority transport services, including streamlining and digitising TROs.

As a result, several projects have followed, and in combination the development of this Data Model. These projects were as follows:

Discovery project (2019) into TROs processes and how this data is made available and used across the country [undertaken by the British Parking Association, Ordnance Survey and Geoplace]. Three significant outputs resulted:

- [User Research](#)
- [User Guide](#)
- [Draft Data Model](#)

DfT-commissioned **Policy Alpha** (2019-20) [undertaken by PA Consulting] to identify improvements to the legislative process in England. Strongly recommended development of the TRO data model as a matter of priority.

Through 2019–20 DfT worked with several local authorities to undertake a **first validation of the TRO Data Model** with 8 Local Authorities and market-leading solution providers.

DfT commissioned the **TRO Data Model Alpha** [undertaken by Valtech] (Sep '20 – Mar '21) giving recommendations on expected market deployment of the TRO data model, and how TRO data from LAs would be made available.

Since mid-2021 there has been on-going further data model validation and enhancement using real-world **Data model Validation** of TROs from four local authorities.

In 2022 DfT undertook a **Policy Consultation** concerning the assessment of changes in TRO legislation.

For more information concerning TROs see the British Parking Association's (BPA) best practice guide for TROs:

https://www.britishparking.co.uk/write/Documents/TIR%20Board/BPA_TRO_Best_Practice_Guide_2019.pdf

In 2023, Informed Solution conducted a **Service Alpha** developing the 3.1.1 version of the data model and conducting pre-production Alpha testing with a small set of TRAs involved.

The **D-TRO Beta project** is currently underway, conducted by PA Consulting, with main updates on the data model proposed being the implementation of records management, live reporting of TTROs and enabling more effective location referencing.

The **Automated Vehicles Act 2024** (clause 93) received Royal Assent in May 2024. It provides statutory instruction for Traffic Regulation Authorities to provide information on a defined set of Traffic Regulation Orders, in a specified manner and form, to be provided in accordance with a specified model, standard or set of specifications.

1.4. High-level outline of the D-TRO Service

The Digital Traffic Regulation Order (D-TRO) service

IS FOR Traffic Regulation Authorities, road network data consumers and Central Government

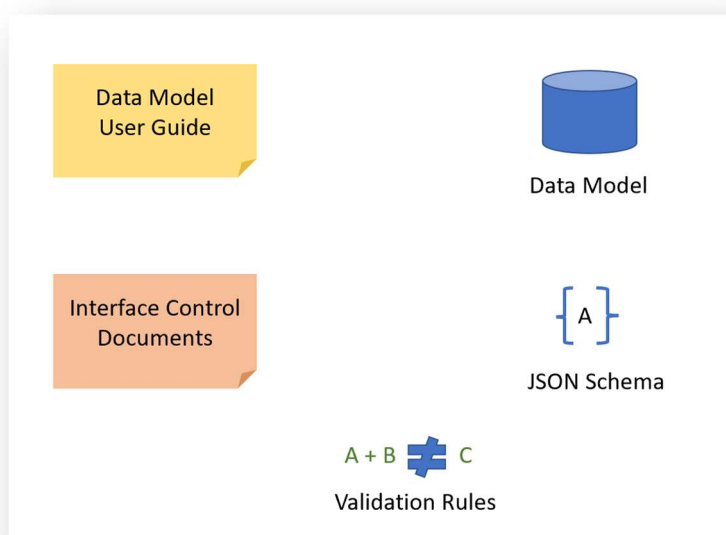
WHO WANT to (1) improve existing services (e.g., satnav routing); (2) provide new services; (3) reduce enforcement and processing costs to highway authorities; (4) reduce congestion; and (5) provision of the digital infrastructure for connected and automated vehicles.

THIS SERVICE WILL BE an API-first digital platform to store and share digital TRO information, enabling the above stated benefits and modernise enforcement on the road network. It is not foreseen as a service to support the creation and initial publication of TROs.

1.5. Other documents and artefacts

This User Guidance is just part of the documents and artefacts that are available in connection to the D-TRO Service:

Figure 1 – Documents and artefacts supporting the D-TRO Service



All the latest versions of documents and other artefacts of this release are listed in GitHub [NEW ISSUE TO BE CREATED].

1.6. Acknowledgements

This document, and the Data Model it describes, draw upon the outputs of earlier projects and has been prepared with the kind support of notably the DfT, Bedford Borough Council, City of York Council, Essex County Council, Transport for the West Midlands, Buchanan Computing, Valtech, Informed Solutions plus other organisations. The report has been authored by Harrod Booth Consulting Ltd and PA Consulting, under contract to the DfT.

1.7. Non-proprietary terms

There are numerous companies currently servicing the TRO market and it is anticipated that this will increase as TROs become more important in the future of transportation.

The Department for Transport do not endorse any particular companies and non-proprietary terms are used throughout this Guidance.

1.8. Disclaimer

This D-TRO Data Model is developmental and experimental in nature. It cannot be considered to be complete or error-free. It should not be viewed as stable and may be subject to alteration without notice.

1.9. Licensing

The material contained within this document is subject to copyright by the DfT and is published under the Open Government Licence v3.0. Further details of the licence can be found at <http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/>.

The DfT are sharing this document and the data model it contains to support iteration and development by the DfT.

2. TRO Modelling Key Concepts

2.1. Background

Data modelling is by its nature open to interpretation, different approaches and may reflect the personal preferences of those developing it.

DfT agreed that the modelling approach would seek to achieve several aims:

- It provides as simple a structure as is possible to model a wide spectrum of traffic regulation concepts as is practicable
- Where appropriate, aligned to internationally recognised standards (see section 2.6).
- Based on an appropriate and relevant data structure.
- Compatible with other standards where possible.
- As open and accessible as possible.

The management and exchange of traffic regulations and TROs is a strengthening need, that will support the digitisation of traffic, vehicle automation and enhanced data-centric transport and mobility services.

Transport and mobility include both the short local and cross-border long-distance journey. There is a need to develop common national mechanisms to ensure the efficient and safe movement of vehicles and road users. Commonality is needed to support travel between jurisdictions, but also the consistent sharing and use of TRO data.

At present, although international conventions support the free movement of road traffic and general conditions for safe common road use, and other road features such as common aspects of road signs, there are no existing common technical standards for how to encode and model road traffic regulations.

This Data Model is the first national recognised effort to support such encoding, expressly for the purpose of exchanging details concerning road traffic regulations, their location and features as well as the traffic impact that they create. This data model is expected to form part of the “with a specified model, standard or set of specifications” specifications as mentioned in the Automated Vehicles Act 2024, clause 93(8).

2.2. General concepts

TROs are complex and have been specified by highway authorities (traffic regulation authorities) over an extended period, with quite some variation of style and approach. Developing the Digital TRO data model is challenging and therefore choices and simplifications are needed. The D-TRO model has been subject to modification and enhancement through a series of projects and also in response to comments and issues raised through validation undertaken by some Local Authorities and their existing TRO software service providers.

Onward reviews and use of this model will identify omissions and exceptions, but the design principles adopted seek to provide clear data modelling constructs to cover a range of key concepts.

When considering TROs there are various aspects that could be the subject of modelling:

- The legal Order itself, as made by the traffic regulation authority (TRA)
- Road network features (instantiated by the Order) that control the movement of traffic, use of the highways, etc, which includes the modelling of the traffic effect of the regulation for that feature

- Modelling of road traffic signs
- Modelling of road markings and other traffic management measures

DfT focus for the D-TRO Data Model has been to develop a firm technical basis to support the encoding, exchange, storage and distribution of details of the legal contents of the TRO itself.

The scope of the D-TRO Data Model covers all different forms of Order (permanent, temporary, experimental and notices) for both moving and stationary traffic.

2.3. Design principles

The following design principles have reflected the shaping of the D-TRO Data Model:

- The scope of the D-TRO Data Model shall cover all different forms of Order (permanent, temporary, experimental and notices) for both moving and stationary traffic.
- The D-TRO Data Model will seek to include the full semantic contents of (a largely majority of) TROs. This notes that there is wide variety in the form and content of existing TROs, and attempting to model all content and options is both impractical and counter-productive to the intent of creating standardised digital TRO records based on a common data structure as defined by the Data Model.
- The D-TRO Data Model will seek to simplify data structures as much as practical.
- The D-TRO Data Model design will be cognisant of user needs in terms of provisioning of digital TRO records, the most likely use cases for consumption and reuse of digital TRO records, and supporting DfT policy objectives, as well as supporting automated validation.
- Where appropriate, the D-TRO Data Model will align and reuse concepts specified in appropriate European or International Standards.
- The D-TRO Data Model shall be extensible. The current landscape, format and content of 'made' TROs contains wide diversity. As part of the process of digitalising and regularising TRO information in the form of D-TRO records, it is essential to try to bound possible options and characteristics in an extensive, inclusive but ultimately limited way. It is important to provide technical mechanisms within the structure of the data model and its implementation in the D-TRO service to enable some of the key vocabulary to be extended in an ad-hoc user driven way.

It is a matter of service governance that use of the extension mechanism, mentioned above, should only be used when absolutely necessary. This will ensure that the consistency of the collected set of D-TRO records is maintained. However, legitimate need to extend values beyond the 'hard coded' values in the Data Model is essential. Regular use of extended items should raise the need for their consideration of inclusion in a revision of the Data Model – as part of the expected regime of data model governance.

- The D-TRO Data Model shall be designed and represented in a manner that aligns with Government policies and is portable, and suitable for long term maintenance.

2.4. User- and Policy-driven needs

As reflected in the design principles, above, on-going work is reviewing user needs for digital TRO records, and therefore the foreseen deployment of the D-TRO Service and the D-TRO Data Model.

This section does not seek to replicate the wide spectrum of needs but highlights a handful of considerations

that shape the way in which the Data Model is expected to be used.

DfT, through the previous Service Alpha and current Beta Project, are reviewing and enhancing user needs analysis, prototyping the D-TRO Service, and reviewing the D-TRO Data Model. Therefore, updates and changes may occur.

The DfT's preferred option is to establish a centralised service which receives digital TROs (D-TROs) from Traffic Regulation Authorities, stores these records, and exposes data services for consumers to request distribution of D-TRO records. The D-TRO Data Model forms the technical baseline for D-TRO records.

Due to the variety of different forms of TRO and notices permitted under the legislation, there is a need to define in future legislation and statutory guidance when in the lifecycle of orders and notices the Traffic Regulation Authority (TRA) will be required to provide a D-TRO record to the D-TRO Service. The current expectation is that the following Reporting Points are needed – see Figure 2.

Figure 2 – D-TRO Reporting Points (Provisional)

	Proposal	Made	Changes	On-road occupancy updates
Permanent TRO/TMO	Notice of Proposals	Notice of Making	Amendment Revocation	
Variation by Notice		Notice of Variation		
TTRO/TTMO by Notice		Notice		On (active) Off (inactive)
TTRO/TTMO by Order	Notice of Intention	Notice after Marking	Revocation Extension	On (active) Off (inactive)
Experimental		Notice of Making	Revocation Amendment Making Permanent	
Special Event Orders		Notice of Making		

These Reporting Points are reflected in the D-TRO Data Model in an enumerated list named 'orderReportingPointType'⁶.

It is not foreseen that the D-TRO Central Service will in the future retain a full, growing library of all D-TROs submitted over time, but retain recently submitted D-TRO records and those that remain current. The Service is also expected to hold future D-TRO records, and those that have recently expired, or replaced by a newer amended version, or revoked. The precise definition of this Service is currently being defined through this Beta project, with initial version for a records management capability being implemented.

2.5. Choice of Technologies

The core D-TRO Data Model has been modelled in UML (Unified Modelling Language) following Model Driven Architecture design principles.

⁶ The on-road reporting of TTRO/TTMO occupancy (on-road – off-road) is managed by a separate mechanism.

JavaScript Object Notation (JSON) is used for definition of schema and the use of REST APIs preferred to meet GDS best practice outlined at <https://www.gov.uk/guidance/gds-api-technical-and-data-standards>

2.6. Alignment with other standards

This document and the Data Model reuse some well-known, widely deployed model fragments that appear in several European and International standards:

- The “Condition” sub-model is specified in both “TN-ITS” CEN/TS17268:2018 and “APDS” ISO/TS 5206-1:2023,
- The “OverallPeriod” sub-model is an adaptation of “Validity” package specified in “DATEX II” CEN/TS 16157-7:2018,
- The “VehicleCharacteristics” sub-model specified in “DATEX II” CEN/TS 16157-7:2018,
- The “Rates” sub-model is specified in “APDS” ISO/TS 5206-1:2023.

However, the D-TRO Data Model has been reviewed for application in the UK, and in some cases the values appearing in the lists contained the Data Model have been adjusted with additions, deletions and adjustments when compared to the Standards content.

The D-TRO Data Model supports conditions that relate to the vehicle type, vehicle usage, vehicle dimensions, fuel type, etc. These condition lists were reviewed from the viewpoint of normal practice in the UK by experienced practitioners. This has resulted in a profiling of these condition types and lists that are more suitable for current UK practice.

2.7. Location Referencing

One of the technical aspects within the D-TRO Beta Data Specification which requires further clarification and resolution, is how to systematically encode information relating to the spatial location and positioning used within TROs. Currently, an approach has been proposed to shape the data structures that are needed to support it within the D-TRO Beta Data Specification and its Data Model.

In order to make future digital TROs useable to the widest set of stakeholders and applications the provision of a coded location that is machine-interpretable and can be related to specific spatially coded locations on digital maps is considered essential.

Following stakeholder comment, DfT has revised the proposed recommended approach. Given the need to reduce barriers to uptake during the D-TRO Beta project phase, no singular preferred approach is mandated. Therefore, for example, a speed limit TRO provision can be represented either by linear road centreline/reference line features (polyline) or by use of a polygon. Similarly, kerb line regulations can be represented as a polyline, a polygon or both. This approach will be reviewed during the D-TRO Beta project, taking on board feedback primarily from data consumers concerning the useability of mixed approach data.

DfT prefers the use of polygons but these are not mandatory.

Some forms of TRO do require special treatment to ensure that the data can be correctly interpreted. This special treatment applies to:

- Gate/point locations
- Directional regulations (such as no entry, one-way streets, turning movements etc.)

There is a need to provide clear guidance and a common approach to enable Traffic Regulation Authorities to code TRO locations.

Single consolidated or other TROs may represent a range of measures (Provisions) impacting different locations - this approach should support Traffic Regulation Authorities identifying and encoding “regulated place” in a manner that they consider appropriate. The approach aims to limit specific coding rules to a practical minimum, enabling both alignment with the more commonly used existing practice whilst counterbalancing use of a limited number of coding mechanisms which will aid greater commonality and interoperability of data.

In general, if a TRO regulation is identified as being effective at two or more distinct locations, each location should be treated as a separate “regulated place”, as laid out in the D-TRO Data Specification. The design approach aims to address the wide spectrum of different forms of shape that TRO regulations can take.

The standardised approach:

- should not be tied to a specific form of reference base map data set.
- shall use a widely understood and supported standardised data format.
- should be cognisant of the level of effort required to achieve it.
- should support the needs of identified use cases, so far as these are defined.
- should separate the principles of what is being encoded, from the actual IT-centric coding mechanism itself.

There is no support in the D-TRO Beta Data Specification to enable the upload of scan or electronic version of TROs, schedules, or associated maps.

2.8. Standardised Terms and Definitions

The transition to digital TROs necessitates the standardisation of terms and definitions to ensure consistency, interoperability, and clarity across different TRAs and platforms.

Standardisation becomes increasingly important to ensure consistency and interoperability by facilitating a uniform understanding of traffic regulations across various regions and platforms. This uniformity is essential for the development of interoperable digital systems that can communicate and integrate seamlessly. For instance, a term like “no-parking zone” should have a universally accepted definition to avoid discrepancies between different technology providers used by TRAs, navigation systems, and other traffic management applications.

Clear and consistent definitions in digital TROs help in maintaining legal clarity. Inconsistent or ambiguous terms can lead to misinterpretation of the regulations, resulting in legal challenges and non-compliance. With DTROs also supporting the rise of intelligent transport systems, autonomous vehicles, and advanced navigation aids, this depends heavily on the availability of standardised digital information. For these technologies to function correctly and interact with human drivers and existing infrastructure, they need access to precise and consistent regulatory data.

Recognising the critical need for standardisation, an assessment is currently underway to collate and analyse the varied uses of terms across different sources relevant to TROs. This comprehensive assessment involves examining the language used in existing TRO documents from multiple authorities, reviewing legislative texts, and consulting with stakeholders in the Traffic Technology Forum and wider. The goal is to identify inconsistencies and ambiguities in the current terminologies and to propose a harmonised set of definitions that can be adopted universally.

3. A tour of the D-TRO Data Model

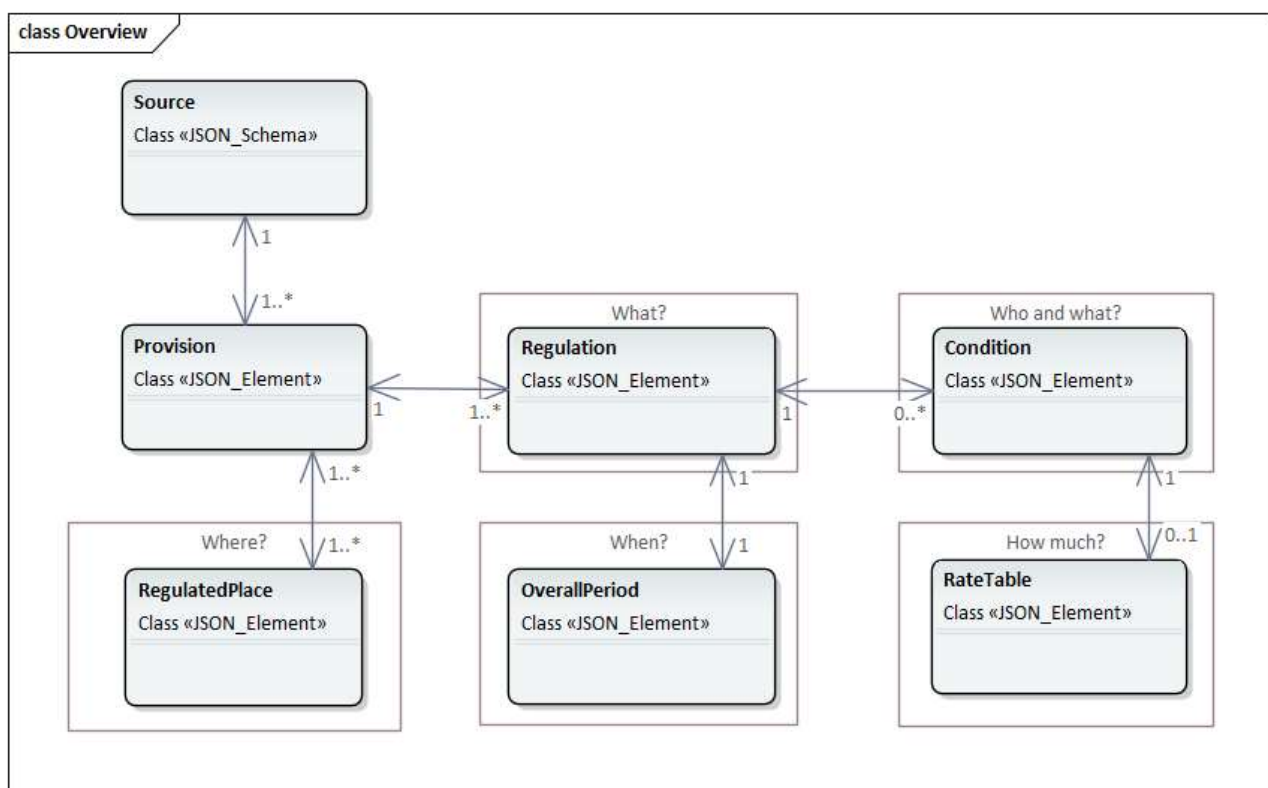
This section provides a tour of the main features of the D-TRO Data Model.

Figure 3 shows a summarised simplified view of the main structures of the D-TRO Data Model. These structures often contain more detailed sub-models, which are detailed later in this section.

One way to think of the organisation of the information is that each Digital TRO record (D-TRO record) contains the information contained in one TRO. Each D-TRO record needs to contain information on the 'what', 'where', 'when', and 'who' concepts. The 'who' concept is covered by what conditions apply, and what exemptions or exclusions exist. For TROs that incur a form of payment or charging, the 'how much' concept can also be expressed.

As denoted in Figure 3, these concepts are held within different structures.

Figure 3 – Summarised view of the D-TRO Data Model



Each of these structures are explained in turn.

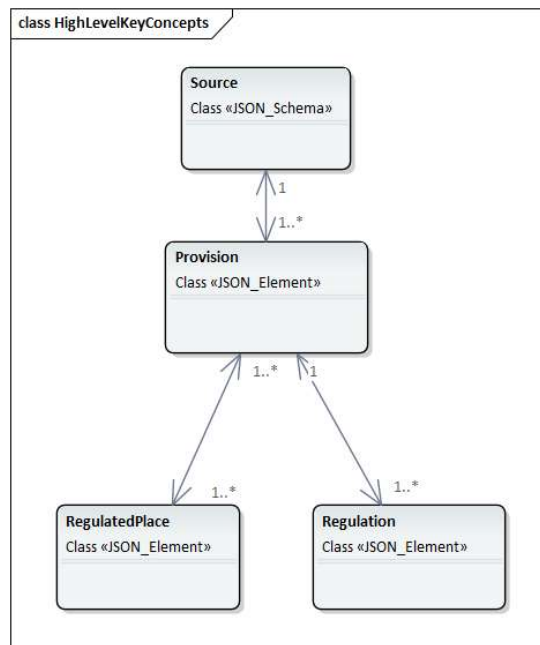
The tour addresses parts of the Data Model as follows:

- About the TRO and its Provisions
- Defining Regulations (what?)
- Specifying Locations for TROs (where?)
- Times relating to Regulations (when?)
- About Conditions and Exclusions - including Vehicle Characteristics (who and what?)
- About Tariff rates (how much?)

3.1. About the TRO and its Provisions

Figure 4 shows some of the top-level concepts of the model, which address details of the TRO as a whole and the provisions it contains.

Figure 4 – Object view of high-level TRO concepts



Each TRO will be characterised by one D-TRO record. In other words, all the informational detail of one TRO should be contained in one D-TRO record.

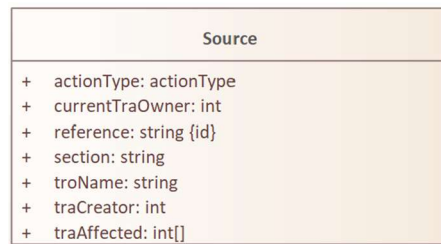
Note: There is a set of metadata attributes that contain information on when the D-TRO record was published by the TRA or their software service provider; and the identity of the publishing entity. These metadata elements form part of the exchange mechanism itself and sit beyond the contents of the data model, forming part of the schema used for exchange. Details of these metadata attributes are provided in the Data Specification’s Interface Control Documents.

The **Source** object contains basic information concerning which TRA which created this TRO, the TRA which is the current owner of the TRO, the Traffic Regulations that are affected by the TRO. The formal published name of the TRO is also supported.

Additionally, **Source** permits linking to any other digitised TRO that is referenced within this TRO. The cross reference is the unique D-TRO record identifier ID, not a textual name of a TRO.

In each D-TRO record, it is possible to define one or many Source objects, with each Source object being related to one section or clause in the TRO.

Figure 5 provides the UML class representation of the Source Object. In this figure the attribute “traAffected” can be used one to many times; this is illustrated by the notation [1..*]. The asterisk * indicates any number of occurrences.

Figure 5 – UML model representation of the Source Object

The **Source** object defines several mandatory attributes.

- The 'troName' attribute gives the cited name of the TRO defined by the TRA. The data type is a (free text) String.
- The 'section' attribute indicates the clause, schedule or article defined by the TRA where the related Provisions can be located. The data type is a (free text) String.
- The 'actionType' attribute indicates the action type to be carried out by the source with a 'reference' ID provided to link to the current source the action is being carried out on. The possible options of action type are illustrated in Figure 6.
- The 'reference' attribute is a unique identifier for each instance of a Source by originating TRA. The precise format of the reference is not prescribed and is left to the discretion of the data supplier. It is however mandatory and shall be unique for originating TRA. The data type is a (free text) String.

Figure 6 - Enumeration values for actionType

The **Source** object also contains three additional experimental mandatory attributes, which may be subject to change to do on-going design considerations.

- The 'traCreator' attribute gives the code for the TRA that created the Order or Notice.
- The 'traCurrentOwner' attribute gives the code for the TRA that is the current responsible party for the Order or Notice.
- The 'traAffected' attribute identifies, by use of the code, one or several TRAs who are affected by the contents of the Order or Notice. This is defined using the integer values for authority codes (SWA codes) in an array.

The codes will be defined in a manner similar to the SWA codes used for street works. These attributes allow the tracing of the original creator and current responsible TRA owner and also those TRAs affected – this supports where boundary changes, authority name changes, etc. It will be quite common for all three attributes to identify the same TRA where no significant changes have occurred and the TRO content relates only to the originating TRA's road network.

We then move on to the **Provision** object. Provisions are an important concept – each instance of Provision

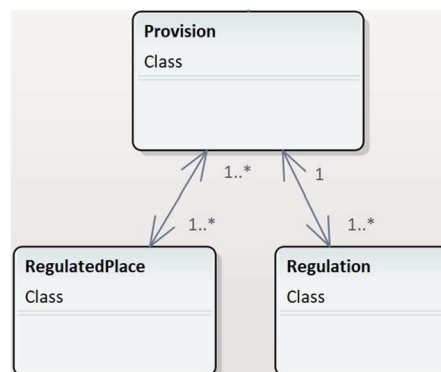
represents specifically one type of **Regulation**, subject to one set of homogeneous conditions (conditions, exemptions, and times of applicability, and, if applicable, tariff rates), that are relevant to one or several **RegulatedPlace(s)**.

Within each TRO, multiple Sources may be defined; with each Source object being related to one section or clause in the TRO.

Related to each Source object, multiple Provision objects may be defined. Each instance of **Provision** shall be related one instance of **Regulation**.

The relationship between the objects Provision, RegulatedPlace and Regulation is shown in Figure 7.

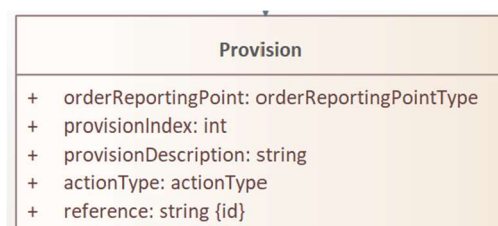
Figure 7 – UML representation of relationship of the Provision, RegulatedPlace and Regulation objects



By way of illustration, consider one TRO that contains two Provisions. The first Provision is, say, a kerbside parking place regulation, regulated to be applicable 24 hours, 7 days per week, relevant to locations A, B and C. The second Provision is, say, a kerbside loading place regulation, regulated to be useable between 06:00 am and 08:00 on weekdays, limited to commercial vehicles, relevant to locations D and F.

Figure 8 provides the UML class representation of the Provision Object.

Figure 8 – UML model representation of the Provision Object



The **Provision** object defines several mandatory attributes.

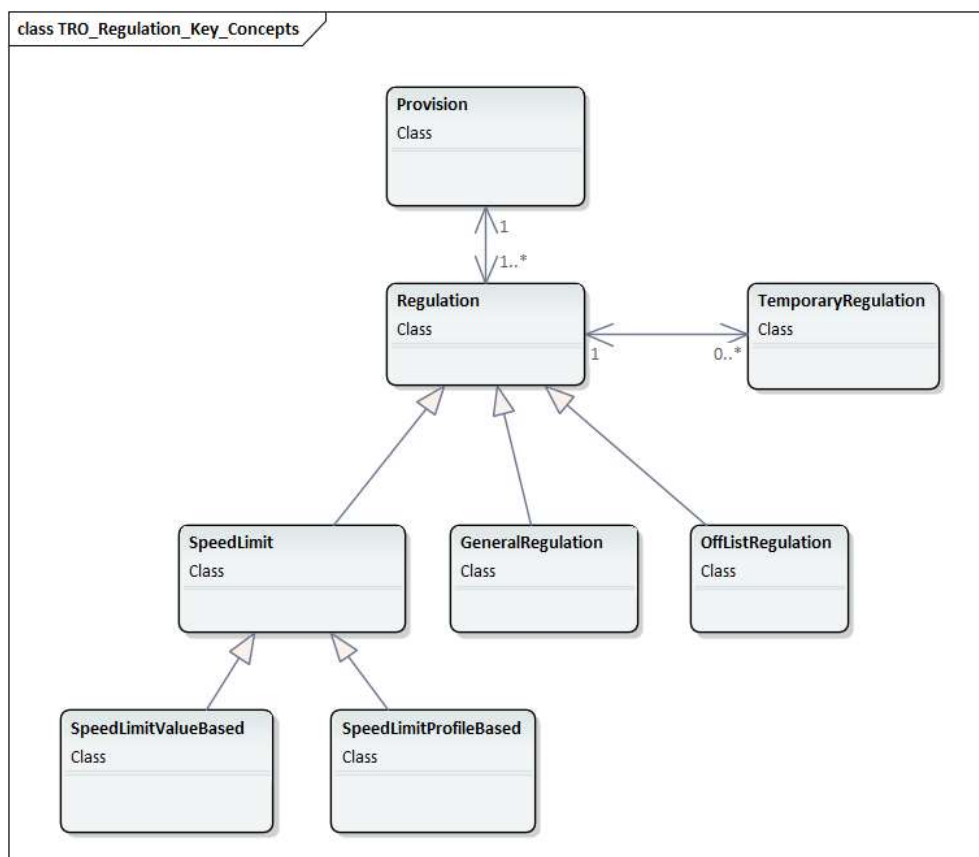
- The 'orderReportingPoint' attribute indicates at which of the recognised Reporting Points this Provision instance rests. Reporting Points are described in more detail in section 2.4.
- The 'provisionIndex' attribute requires use of a unique identifier for each instance of a Provision by originating TRA. The precise format of the provisionIndex is not prescribed and is left to the discretion of the data supplier. It is however mandatory and shall be unique for originating TRA. The data type is a (free text) String.
- The 'provisionDescription' attribute provides a free text description of the referenced Provision. It is mandatory. The data type is a (free text) String.
- The 'actionType' attribute indicates the action to be carried out by the provision with a 'reference' ID provided to link to the current provision the action is being carried out on.

- The 'reference' attribute is a unique identifier for each instance of a Provision by originating TRA. The precise format of the reference is not prescribed and is left to the discretion of the data supplier. It is however mandatory and shall be unique for originating TRA. The data type is a (free text) String.

3.2. Defining Regulations

Figure 9 shows some of the objects concerned with the definition of a Regulation with the model.

Figure 9 – Object view for Regulation



As stated above, each instance of **Provision** shall be related to at least one instance of **Regulation**, but potentially several.

Each **Regulation** object defines one and only one form of regulation.

Regulations fall into one of three categories:

- **SpeedLimit** – characterising speed limit regulations. The speed limit regulations are in turn, divided into two sub-categories:
 - **SpeedLimitValueBased** – which are speed limit regulations based upon a declared speed limit. As the default speed limit for well-lit streets may not be 30 mph, it is necessary to define the value alongside the speedLimitValueType enum.
 - **SpeedLimitProfileBased** – which are based on speed limit regulations. For example, one profile is 'nationalSpeedLimitDualCarriageway', and another is 'nationalSpeedLimitSingleCarriageway'
- **GeneralRegulation** – characterising a wider range of regulations – see later for further details.

- OffListRegulation – which characterises an extension mechanism for a TRA to declare a form of Regulation that is not otherwise covered by the regulations specified in the first two categories.

In instances where a temporary regulation temporarily replaces a pre-existing regulation the **TemporaryRegulation** object may be used to indicate references to pre-existing regulation(s).

Figure 10 provides the UML class representation of the TemporaryRegulation Object.

Figure 10 – UML model representation of the TemporaryRegulation Object

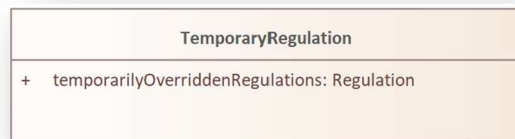
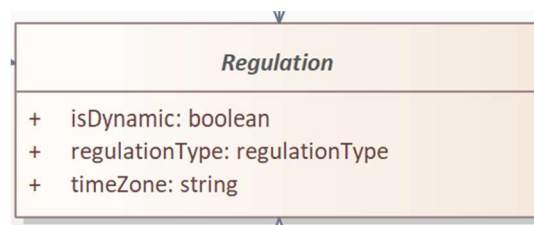


Figure 11 provides the UML class representation of the Regulation Object.

Figure 11 – UML model representation of the Regulation Object

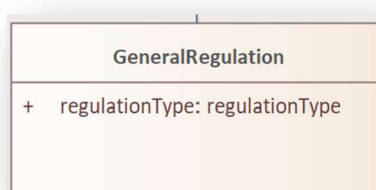


The **Regulation** object defines three mandatory attributes.

- The 'isDynamic' attribute indicates whether the Regulation identified is dynamic in nature (i.e., the Regulation is triggered by some condition – for example, changeable speed limits, access regulations, or triggered by environment conditions). The value 'True' indicates the Regulation is dynamic in nature; 'False' indicates the Regulation is static.
- The 'timeZone' attribute enables the time zone applicable to the Regulation to be defined. This is important in supporting the management of the definition of clearly specified times that work appropriately in local time zones. The time zone is specified IANA time zone (see <http://www.iana.org/time-zones>). For regulations in the UK will be "Europe/London".

Figure 12 provides the UML class representation of the GeneralRegulation Object.

Figure 12 – UML model representation of the GeneralRegulation Object



The **GeneralRegulation** object has one mandatory attribute.

- The 'regulationType' attribute holds an indication of the type of Regulation. The potential list of regulation types is extensive.

The list given in release 3.2.0 of the Data Model is as follows:

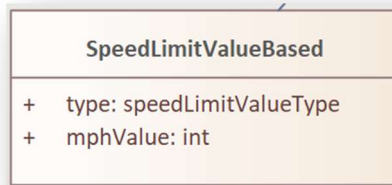
kerbside-RuralClearway
kerbside-NoLoading
kerbside-NoStopping
kerbside-NoWaiting
kerbside-SchoolKeepClear-YellowZig-zag_mandatory
kerbside-OtherYellowZig-zag_mandatory
kerbside-UrbanClearway
kerbside-RedRouteClearway
kerbside-FootwayParkingProhibited
kerbside-DisabledBadgeHoldersOnly
kerbside-LimitedWaiting
kerbside-LoadingPlace
kerbside-MotorcycleParkingPlace
kerbside-TaxiRank
kerbside-LoadingBay
kerbside-ParkingPlace
kerbside-PaymentParkingPlace
kerbside-PermitParkingPlace
kerbside-FootwayParking
kerbside-PermitParkingArea
kerbside-ControlledParkingZone
kerbside-RestrictedParkingZone
nonOrderKerbside-BusStop
nonOrderKerbside-PedestrianCrossing
bannedMovement-NoRightTurn
bannedMovement-NoEntry
bannedMovement-NoLeftTurn
bannedMovement-NoU-turn
mandatoryDirection-AheadOnly
mandatoryDirection-OneWay
mandatoryDirection-LeftTurnOnly
mandatoryDirection-RightTurnOnly
movementOrder-NoOvertaking
movementOrder-ProhibitedAccess
movementOrder-PriorityOverOncomingTraffic
nonOrderMovement-BoxJunction
dimension-MaximumHeight_withTRO
dimension-MaximumWeight_environmental
dimension-MaximumWidth
dimension-MaximumHeight_Structural
dimension-MaximumLength
dimension-MaximumWeight_structural
other-BusLane-WithTrafficFlow
other-BusOnlyStreet
other-BusGate
other-ContraflowBusLane
other-Congestion-LowEmissionZone
other-CycleLane
other-PedestrianZone

Note: It is acknowledged that existing practice for defining TROs in different Traffic Regulation Authorities may use slightly different terms to describe what fundamentally are the same regulatory concept. To improve the interoperability of TRO data coming from different Traffic Regulation Authorities, mapping of locally adopted terms to the regulation types given in the list above is essential. Genuinely new, distinct

regulation concepts can be provided using the OffListRegulation mechanism described below – but this should be rarely used.

Figure 13 provides the UML class representation of the SpeedLimitValueBased Object.

Figure 13 – UML model representation of the SpeedLimitValueBased Object

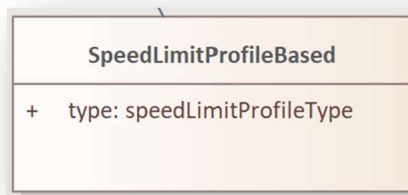


The **SpeedLimitValueBased** object has two mandatory attributes:

- The 'type' attribute indicates the type of speed limit being defined, with potential values: 'maximumSpeedLimit', 'minimumSpeedLimit', and 'nationalSpeedLimitWellLitStreetDefault'
- The 'mphValue' gives the integer value for the speed limit identified, given in miles per hour.

Figure 14 provides the UML class representation of the SpeedLimitProfileBased Object.

Figure 14 – UML model representation of the SpeedLimitProfileBased Object



The **SpeedLimitProfileBased** object has one mandatory attribute.

- The 'type' attribute indicates the type of profile for speed limit being defined, with potential values: 'maximumSpeedLimit', 'minimumSpeedLimit', and 'nationalSpeedLimitWellLitStreetDefault'

The D-TRO Data Model is experimental in nature and there is a real-world road network usage and therefore TROs (e.g., consider the relatively recent introduction of e-Scooters). The data model supports a couple of different approaches to support extension to new situations and regulations.

If a new form of regulation is required, beyond those already specified in the Data Model, the **OffListRegulation** object can be used.

Figure 15 provides the UML class representation of the OffListRegulation Object.

Figure 15 – UML model representation of the OffListRegulation Object

The OffListRegulation object has three attributes:

- The mandatory 'regulationShortName' attribute enables the TRA to give a short name for the new extended regulation type. This typically is less than 30 characters in length. For example, "kerbside – eScooter parking" or "kerbside – public mobile robot parking".
- The mandatory 'regulationFullText' attribute contains the full descriptive text used in the TRO for the new extended regulation type.

Optionally, multiple references to the new extended regulation may be provided. This may be a reference to a clause in the TRO or a Uniform Resource Identifier (URI) to supporting published material.

3.3. Managing records for TROs and corresponding provisions

Note: A key enhancement to the data model for Beta is the Records Management concept to help link together TROs and provisions, supporting different forms of orders, order provisions and notices that come into the D-TRO Central Service, particularly in the case of amendments, revocations, variations by notice and consolidations.

As part of records management, the Central Service will maintain a "live TRO" list, which may be modified by the receipt of a new inbound Order or Notice received by the Central Service.

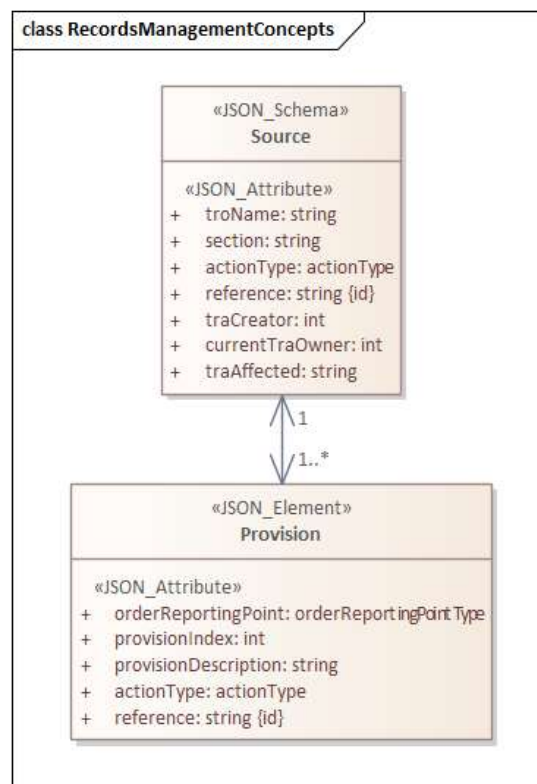
- An **Amendment** Order can change or remove anything in an existing order – or orders – and add new provisions and revoke other orders.
 - A revocation is a type of amendment order, that does not have any new provisions. An order that only contains revocations will still be advertised and consulted upon. The receipt of a record that is identified solely as a revocation into the central service, does not automatically mean that any referenced previous orders will be removed from the "live TRO" list. An order that is solely a revocation may only revoke parts of an old order and leave other parts intact – this may be a partial revocation of a Provision within a previous TRO.
- Parking tariffs are varied by use of a **variation by notice**. As the initial tariffs may have been specified in the original full order, this can have the effect of being an amendment to it.
- A **consolidation** is an administrative process and nothing 'of substance' should be added or removed. Generally, a consolidation would combine a base order and its subsequent amendments into a new base order. If something is missed from the revocation list of a consolidation, then the remaining pre-existing Provisions (partial or whole) might be orphaned but still be in force. These always have multiple revocations, by definition.
- A **consolidation** can be used to change some details of a previously made TRO, so long as this does not affect the substance of the Order. Things can be tidied up if required (noting there is small defined list of minor changes that are allowed) but nothing should be changed that

would ordinarily require consultation. The opportunity to make changes is very limited. However, as a side note, this can be complicated by the fact that some people refer to the combination of old orders with substantial changes as a consolidation, which it is not.

We require that all (versions of) Orders and Notices received shall contain “minimum contextual content” (i.e. the who, what, when and how much, if relevant, of any Provision). This requirement is defined by the minimum mandatory data elements within the Data Model. Effectively new versions will replace older versions within the Live TRO list - old versions will remain visible for a while.

Whilst the central service currently will hold records for all D-TRO records it has received, D-TRO records management mean that new versions of TROs (and their Provisions) – through amendments and revocations – will supersede earlier versions. Each version is considered to be a complete representation of the TRO and its Provisions. Older records that have been amended or revoked will be visible in the Central Service for a defined retention period, before being archived.

Figure 16 – Objects View for Records Management related objects



The Source and Provision objects have been described above in section 3.1.

3.4. Specifying Locations for TROs

Note: Following key stakeholder engagement, no singular preferred approach to location referencing is mandated at this current stage. During the D-TRO Beta project, feedback provided from data consumers will inform the usability of data provided through the mixed approaches for location referencing.

In order to make future digital TROs useable to the widest set of stakeholders and applications the provision of a coded location that is machine-interpretable and can be related to specific spatially coded locations on digital maps is considered essential. Providing clear information on the geographic spatial location that are subject to regulations is a critical element of the D-TRO record.

No single preferred approach is mandated at this current stage. Therefore, for example, a speed limit TRO provision can be represented either by linear road centreline/reference line features (polyline) or by use of a polygon. Similarly, kerb line regulations can be represented as a polyline, a polygon or both.

The following sections lay out a standardised approach for how the location data for TRO regulations should be handled. All TRO regulation measures shall be defined geospatially, using coordinates and coded in WKT (Well Known Text) format.

The standardised approach covers general concepts, such as where to place spatial polygons or polyline in different circumstances, which is expected to be appropriate for most forms of TRO regulation.

The standardised approach addresses:

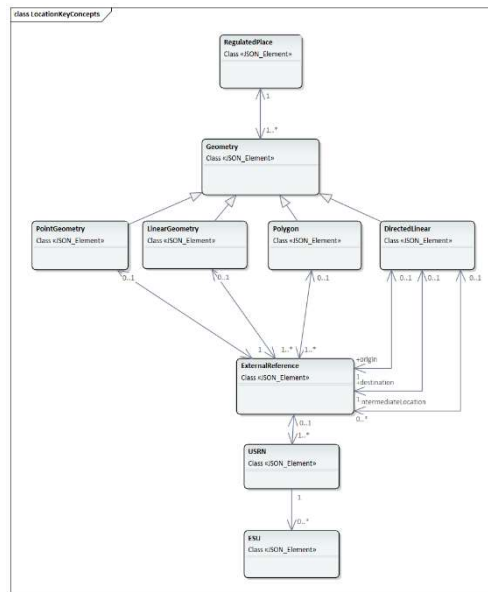
- Instances where TRO regulations are subject to a direction, such as one-way streets, no entry restrictions, banned turns, etc
- Cases where TRO regulations may apply to roads that appear coincident on a map but are grade separated vertically.
- The topic of providing additional contextual information that enables the TRO regulation locations to be associated directly with references found in well-known road network model data sets, specifically the National Street Gazetteer.
- Other forms of TRO regulation location which can be considered more point-like, such as gate access regulations, some height, width, weight regulations.

A TRO may contain multiple distinct regulations (measures) which relate to potentially numerous Regulated Places. The shape/geometry of the spatial footprint of a Regulated Place may not be well defined in existing and current new TROs. Table 1 provides an overview of the forms of shape/geometry for TRO regulations.

Table 1 - Geometry examples for different forms of regulation

Section of whole road (e.g. speed limit, one way street)	Lane-based (e.g. bus lane restrictions, HOV lanes)
Point/gate (e.g. bus gate, width access control)	Zone/Area (polygon) (e.g. Controlled Parking Zone, 20 mph speed zone)
Section of kerb line (e.g. parking/loading restrictions)	Turning movement (e.g. banned turns)

Figure 17 provides the UML class representation of the location related objects.

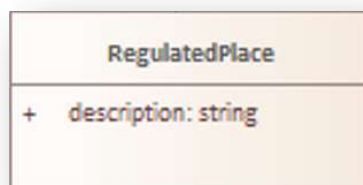
Figure 17 – UML model representation of Location related objects

Each instance of **Provision** shall be related to at least one **RegulatedPlace**.

A **RegulatedPlace** represents a real-world identifiable location which is where the Provision and related Regulation(s) are applicable to. There is no particular limitation or rules concerning specifying a RegulatedPlace, or choosing to define the zone of influence into several RegulatedPlace – this is a choice of the TRA.

Each RegulatedPlace shall have one or, potentially more than one, specified **Geometry**. This is a change to previous versions of the data model. If multiple Geometry instances exist for a RegulatedPlace each Geometry instance represents an alternative version (alternative representation) of the same location. They are not intended to define different real-world locations. Each instance of Geometry for a RegulatedPlace shall have a unique version attribute value (see Figure 19 below). This enables a TRA to represent a RegulatedPlace using, say, a polygon-based geometry in one version, and a polyline-based geometry in a second version.

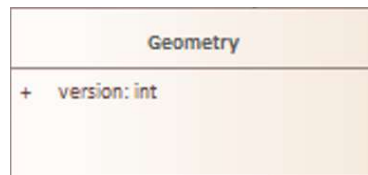
Figure 18 provides the UML class representation of the RegulatedPlace Object.

Figure 18 – UML model representation of the RegulatedPlace Object

Each RegulatedPlace has a description given in a free-text string in the 'description' attribute. This can support the traditional textual description of the relevant location (e.g. Henbury Way).

Each **RegulatedPlace** is linked to at least one, and potentially more than one, **Geometry** object.

Figure 19 provides the UML class representation of the Geometry Object.

Figure 19 – UML model representation of the Geometry Object

The Geometry object has one attribute:

- The mandatory 'version' attribute which Indicates the version number of the Geometry instance defined.

The OSGB36 / British National Grid Coordinate Reference System (ESPG:27700) shall be used.

OSGB36 is well aligned with other local authority data obligations (NSG, LLPG) and provides a baseline CRS that is anchored on the UK.⁷

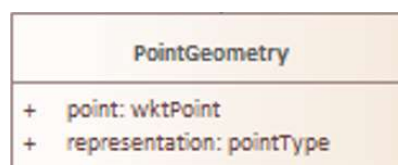
Note: The geometry solution given above emerged from the Valtech Alpha project and has been developed during this Beta project. It is now being subject to prototyping and therefore comments and suggestions for input from relevant stakeholders are welcomed to help develop further.

The details provided in the Geometry object alone is not sufficient to define the spatial geometry of the RegulatedPlace and provide meaningful semantic content to explain what the given geometry means. Therefore, four specialisations of different forms of geometry are supported.

The four specialisations are:

- PointGeometry - where the supplied geometry identifies a point location, the context of this point location is given in the PointGeometry object.
- LinearGeometry - where the supplied geometry identifies a polyline location, the context of this polyline (linear location) is given in the LinearGeometry object.
- Polygon - where the supplied geometry identifies polygon (zone or area) location, the context of this polygon location is given in the Polygon object.
- DirectedLinear - where the supplied geometry a defined movement between two (or linked multiple more) locations (such as defining a banned turn between North Way and East Street), the context of motion (directed linear location) is given in the DirectedLinear object.

Figure 20 provides the UML class representation of the PointGeometry Object.

Figure 20 – UML model representation of the PointGeometry Object

The use of the PointGeometry class is preferred for point / gate locations.

⁷ See HM Government guidance on the use of Coordinate Reference Systems - [UK Geospatial Data Standards - Coordinate Reference Systems](https://www.gov.uk/government/guidance/uk-geospatial-data-standards-coordinate-reference-systems) - GOV.UK (www.gov.uk)

The PointGeometry object has a single mandatory attribute, 'representation' which indicates the nature of the point location for a point representation of a regulated place. Acceptable values are: 'centreLinePoint', 'trafficSignLocation', and 'other'.

Table 2 - Examples of WKT encoding

The specific form of standardised data encoding to be used to structure TRO location data in a way that is consistent robust and commonly interpreted. Use of both GeoJSON or WKT [Well Known Text] conventions have been considered. However the latest edition (2016) of GeoJSON ([RFC 7946](#)) only permits the use of WGS84 coordinates, and therefore cannot be used given the coordinate referencing system decision above.

Coding of geometric data shall conform to the WKT standard ([ISO/IEC 13249-3:2016](#)).

The coding of wktPoint, wktPolygon and wktLineString shall follow the WKT geometry standard - ISO/IEC 13249-3:2016. An example is illustrated in Table 2.

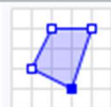
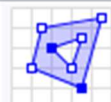
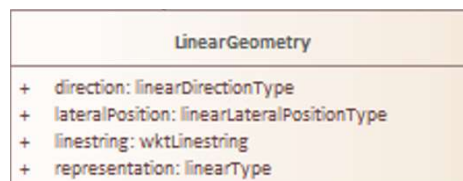
Polygon		POLYGON ((30 10, 40 40, 20 40, 10 20, 30 10))
		POLYGON ((35 10, 45 45, 15 40, 10 20, 35 10), (20 30, 35 35, 30 20, 20 30))

Figure 21 provides the UML class representation of the LinearGeometry Object.

Figure 21 - UML model representation of the LinearGeometry Object



The LinearGeometry object has four attributes:

- The mandatory 'representation' attribute which identifies where the given linear geometry is represents a linear feature location (e.g., a stretch of kerbline) and is a representation of zonal object (e.g., the reference centre-line of a length of road, where the location of applicability is the whole width of the road for the defined length).
- The mandatory 'direction' attribute indicates the direction of the applicability of the referenced regulation. Acceptable values are: 'bidirectional', 'startToEnd', and 'endToStart'. Note this can be used to support the definition of the direction of a direction sensitive regulation on, say, a single road section (e.g. a northbound direction {from the start to the end of the sequence of vertices that exists within the polyline} on a one-way street).

This is distinct from trying to define turning motions between two identifiable road sections. For a LinearLocation the mandatory link to the National Street Gazetteer may indicate only one USRN of relevance (i.e. a single NSG street). The DirectedLinear requires reference to a start and an end USRN (i.e. two).

- The mandatory 'lateralPosition' attribute indicates the lateral position across a road of the linear representation of a regulated place. Acceptable values are: 'centreline', 'onKerb', and 'near' and 'far'. The values near and far are not currently defined in any detail!
- The mandatory 'linestring' attribute is a free text field holding the WKT coded representation of vertices forming a linestring. By default, two coordinate values per vertex are used, however and optional third attribute can be defined in instances where the vertical separation of roads and regulations need to be defined.

Figure 22 provides the UML class representation of the Polygon Object.

Figure 22 - UML model representation of the Polygon Object

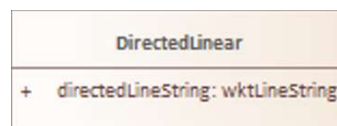


The Polygon object has one attribute:

- The mandatory 'polygon' defines a coordinate-polygon that represents the extent of the road subject to the TRO regulation. The mandatory 'polygon' attribute is a free text field holding the WKT coded representation of vertices forming a polygon. By default, two coordinate values per vertex are used, however and optional third attribute can be defined in instances where the vertical separation of roads and regulations need to be defined.

Figure 23 provides the UML class representation of the Directed Linear Object.

Figure 23 – UML model representation of the Directed Linear Object

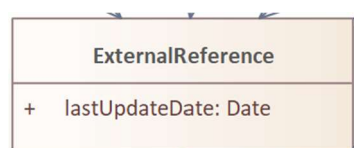


The DirectedLinear object has one attribute:

- The mandatory 'directedLineString' specialisation is used for specifying regulations for turning movements or directional regulations. The mandatory 'directedLineString' attribute is a free text field holding the WKT coded representation of vertices forming a polyline. In this case, the sequence of vertices defined is considered to be significant, the first vertex being considered the start of the directedLineString; and the last vertex being considered the end of the directedLineString. Intermediate additional vertices can be added if they are considered to clarify routing through the road network, between the start and the end. By default, two coordinate values per vertex are used, however and optional third attribute can be defined in instances where the vertical separation of roads and regulations need to be defined.

Figure 24 provides the UML representation of External Reference Object.

Figure 24 - UML model representation of the External Reference Object

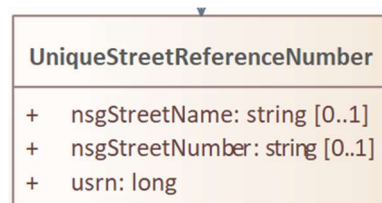


The ExternalReference object has one attribute:

- The mandatory 'lastUpdateDate' is a date to specify when this cross reference was established, as USRNs and ESUs do occasionally change.

Figure 25 provides the UML representation of Unified Street Reference Numbers object. Each **RegulatedPlace** shall be cross-referenced to one or more Unified Street Reference Numbers (USRN) as specified in the National Street Gazetteer (NSG), by use of the 'usrn' attribute.

Figure 25 - UML model representation of the UniqueStreetReferenceNumber Object



The USRN object has three attributes:

- The mandatory 'nsgStreetName' and 'nsgSteetNumber' are the street name and street reference numbers in the Gazetteer for the Regulated Place. 'nsgStreetName' and 'nsgSteetNumber' attributes are optional, however it is mandatory that one attribute shall be filled, for all road lengths that appear in the NSG.
- The mandatory 'usrn' attribute is the designated Unified Street Reference Number derived from the NSG.

Figure 26 provides the UML representation of ESU Object.

Figure 26 - UML model representation of the ElementaryStreetUnit Object

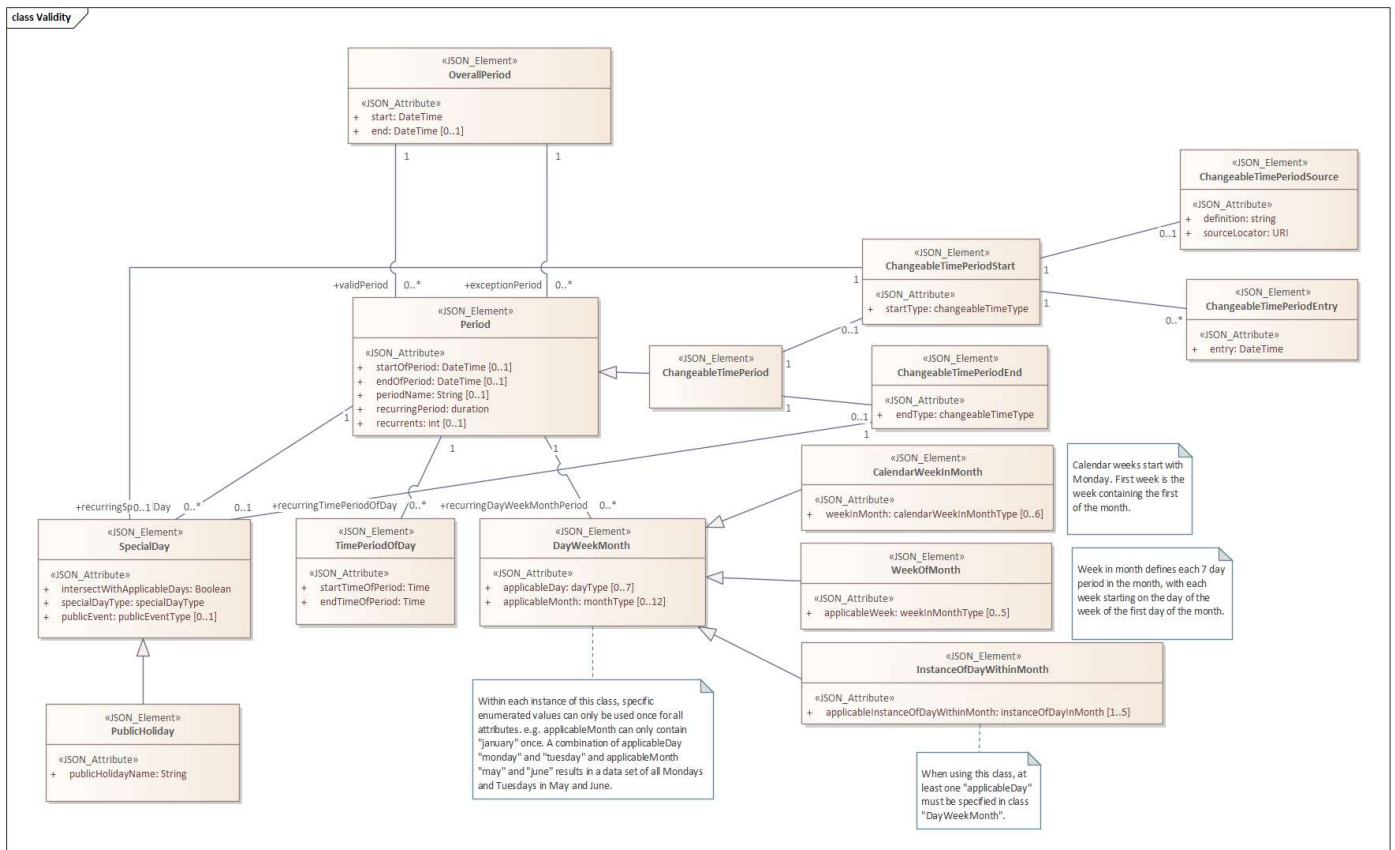


The ESU object has one attribute:

- The optional 'esu' represents the Elementary Street Unit (ESU) derived from the NSG, relating to the origin and destination locations shall be specified, where they exist in the NSG.

3.5. Times relating to Regulations

Date and time information relating to Regulations is defined using a tried and tested sub-model which appears in several European technical standards and is widely deployed. Each instance of the **Regulation** object is linked to one instance of the **OverallPeriod** object, which is the top of the time-based Validity sub-model. The full Validity sub-model is shown in Figure 27.

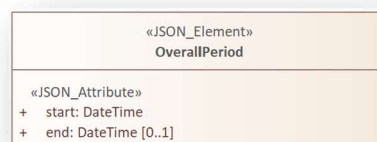
Figure 27 - UML model representation of Validity (Time-based) related objects

Use of each object and its attributes is given below.

For all dates and times, the following should be noted:

- Dates and times – all date and time records shall be expressed using the ISO 8601-1:2019 extended format (e.g., YYYY-MM-DDTHH:MI:SSZ).
- Durations – all durations shall be expressed using the ISO 8601-1:2019 abstract notation format for duration (e.g., P3D).

Figure 28 provides the UML class representation of the OverallPeriod Object.

Figure 28 – UML model representation of the OverallPeriod Object

The OverallPeriod object defines overall dates and times relating to the applicability of a Regulation. It shall be used to specify the bounding start and end times of the validity period, within which there may be any number of valid and invalid (exception) periods. The 'start' date time attribute is mandatory – in the case where the D-TRO record characterises a historic, live regulation and the actual date and time of applicability is unknown the start attribute should be set to the current time.

For permanent TROs the end attribute may be omitted.

The Validity model allows intermittent or variable patterns of time applicability for TRO regulations to be specified.

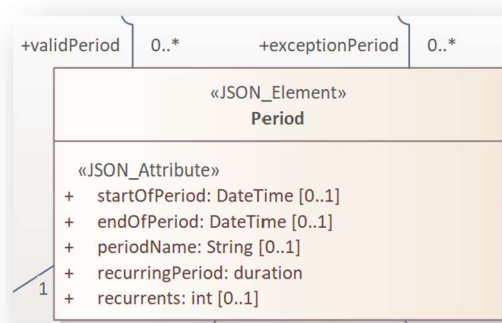
Figure 29 shows the UML class representation of the Period Object, but also note the two links at the top of the figure, which allow instances of the Period object to be specified either as a valid period (i.e., an included period) or an exception period (i.e., an excluded period where the regulation is not applicable).

Note: it is a matter of data quality and integrity on behalf of the data supplier to ensure the dates and times and periods of applicability are complete, consistent and coherent – there is nothing in the Data Model per se that stops contradictory or conflicting information being specified. Data suppliers should take appropriate steps to ensure the quality of the data supplied.

The overall validity period defined in the “OverallPeriod” object by the “startOfPeriod” and “endOfPeriod” attributes shall strictly bound (i.e., override) any periods defined in the Period object.

Note that where an invalid (exception) period overlaps (intersects) a valid period the validity shall be regarded as invalid.

Figure 29 – UML model representation of the Period Object



Each instance of Period may have a given periodName, and, also may have specified date times indicating the startOfPeriod and endOfPeriod. If the startOfPeriod or the endOfPeriod are unspecified the date times of the related OverallPeriod object instance may bound applicability.

An instance of a Period object is typically used to define patterns of applicability of a regulation (or exceptions). This is done in conjunction with several ‘child’ objects. These are described below. These ‘child’ objects can be combined in several ways to express different patterns.

An illustrative example is a permanent TRO for a parking restriction. This fictitious TRO was made in early 2022 and came in effect on 1st June 2022. It is applicable between 15th June and 30th September each year, and between the hours of 07:00 and 09:30am and again between 16:00 and 18:30 on weekdays, except public holidays.

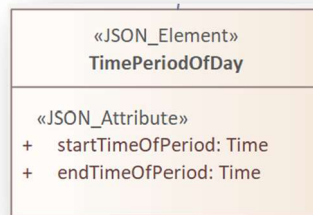
The optional attribute “recurringPeriod”, if populated, indicates that the startOfPeriod and endOfPeriod attributes are considered to define the first instance of a recurring period. The attribute “recurringPeriod” defines the duration between the start of instances of recurring periods.” The “recurrences” attribute is optional and can define a number of repetitions if required – this is not typically the case of permanent regulations.

To support use cases where the start and ends of recurring periods are defined by a changeable date (such as Good Friday, or Easter), the use of the ChangeableTimePeriod object and its children allowed

changeable dates to be defined, and these will override the startOfPeriod and endOfPeriod attributes.

Figure 30 provides the UML class representation of the TimePeriodOfDay Object.

Figure 30 - UML model representation of the TimePeriodOfDay Object



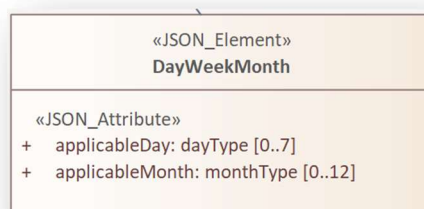
The TimePeriodOfDay object has two mandatory attributes, which indicate the time of day of the start and end of the period.

In the example given above, the first instance of the TimePeriodOfDay object contains the attribute 'startTimeOfPeriod' with the value 07:00am (07:00:00Z) and the attribute 'endTimeOfPeriod' with the value 09:30am (09:30:00Z). The second instance of the TimePeriodOfDay object contains the attribute 'startTimeOfPeriod' with the value 4:00pm (16:00:00Z) and the attribute 'endTimeOfPeriod' with the value 6:30pm (18:30:00Z).

The value of startTimeOfPeriod must fall before the value of endTimeOfPeriod within a one-day period.

Figure 31 provides the UML class representation of the DayWeekMonth Object. This object and its associated specialisation (CalendarWeekInMonth, WeekOfMonth, and InstanceOfDayWithinMonth) enable identification of patterns days, weeks and months.

Figure 31 - UML model representation of the DayWeekMonth Object



The DayWeekMonth object has two optional attributes:

- The 'applicableDay' attribute indicates days of the week to be included. The attribute may be used between zero and 7 times, with each attribute instance being a unique day of the week. Permitted values are 'monday', 'tuesday' etc.

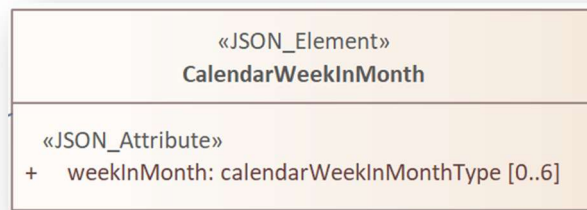
In the example above applicableDay would be specified 5 times, with the values 'monday', 'tuesday', 'wednesday', 'thursday', and 'friday'. The order of the attribute values is unimportant.

- The 'applicableMonth' attribute indicates months of the year to be included. The attribute may be used between zero and 12 times, with each attribute instance being a unique month of the year. Permitted values are 'january', 'february', etc.

Figure 32 provides the UML class representation of the CalendarWeekInMonth Object. This object enables specification of Calendar weeks within a month to be included. See ISO 8601 for further details. The first

Calendar week contains the first of the month, with the Calendar week starting on a Monday. Several days of the first week of the month may occur in the previous calendar month. By construction, the last week of a preceding month can also be the first week of a subsequent month.

Figure 32 - UML model representation of the CalendarWeekInMonth Object



The CalendarWeekInMonth object has one optional attribute:

- The 'weekInMonth' attribute indicates the Calendar week of the month to be included. The attribute may be used between zero and 6 times, with each attribute instance being a unique Calendar week in month identifier. Permitted values are 'firstWeekofMonth', 'secondWeekOfMonth' ... to 'sixthWeekOfMonth'.

Figure 33 provides the UML class representation of the WeekOfMonth Object. The WeekOfMonth object provides information concerning an identifiable week in a calendar month - where the week starts on the same day of the week as the month. E.g., if the first of the month is a Wednesday, each week in a month identified here also starts on a Wednesday.

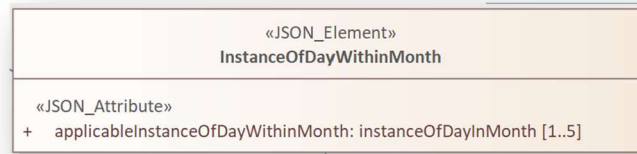
Figure 33 - UML model representation of the WeekOfMonth Object



The WeekInMonth object has one optional attribute:

- The 'applicableWeek' attribute indicates the week of the month to be included. The attribute may be used between zero and 5 times, with each attribute instance being a unique week in month identifier. Permitted values are 'firstWeek', 'secondWeek' ... to 'fifthWeek'.

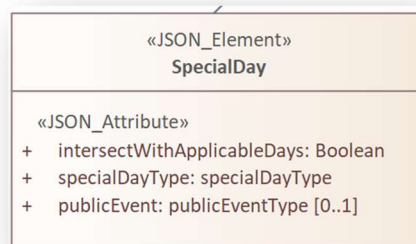
Figure 34 provides the UML class representation of the InstanceOfDayWithinMonth Object. The InstanceOfDayWithinMonth Object enables identification of Instances of a day of the week in a month. For example, the second Tuesday in the month. When using this object, at least one "applicableDay" instance shall be specific in the related object "DayWeekMonth".

Figure 34 - UML model representation of the InstanceOfDayWithinMonth Object

The `InstanceOfDayWithinMonth` object has one mandatory attribute:

- The 'applicableInstanceOfDayWithinMonth' attribute indicates the identified day instance within the month to be included. The attribute shall be used between one and 5 times, with each attribute instance instance of an identified day in a month. Permitted values are 'firstInstance', 'secondInstance' ... to 'fifthInstance'. This can be used to define patterns such as the second and fourth Tuesday and Friday in the month.

Figure 35 provides the UML class representation of the `SpecialDay` Object. The `SpecialDay` object indicates the characteristics of an identified (special) day.

Figure 35 - UML model representation of the SpecialDay Object

The `SpecialDay` object has three attributes:

- The mandatory 'intersectWithApplicableDays' attribute, specified as a Boolean. When true, the period is the intersection of applicable days and this special day. When false, the period is the union of applicable days and this special day.
- The mandatory 'specialDayType' attribute which indicates the type of the special day. Permitted values are defined in the `specialDayType` enumeration list. Values include: 'easter', 'marketDay', 'matchDay', 'publicHoliday' etc.
- The optional 'publicEvent' attribute which indicates what type of public event is associated with this `specialDay`. Permitted values are defined in the extensive `publicEventType` enumeration list. Values include: 'agriculturalShow', 'airShow', 'artEvent', etc.

Figure 36 provides the UML class representation of the `PublicHoliday` Object. The object `PublicHoliday` with its mandatory attribute 'publicHolidayName' enables the public holiday to be named.

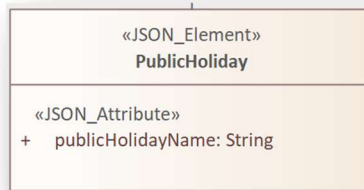
Figure 36 - UML model representation of the PublicHoliday Object

Figure 37 provides the UML class representation of the ChangeableTimePeriod Object.

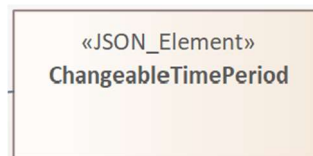
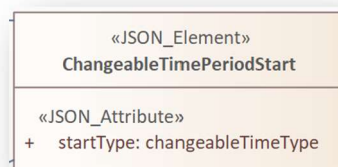
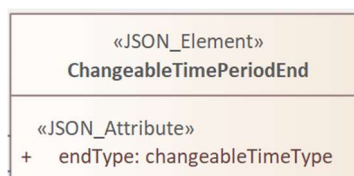
Figure 37 - UML model representation of the ChangeableTimePeriod Object

Figure 38 provides the UML class representation of the ChangeableTimePeriodStart Object. There is a mirror image object called ChangeableTimePeriodEnd. Both objects work in a similar manner. A fuzzy time period is defined in several European standards as the time period with non-precise characteristics. However, this is actually a poor definition for the concept. The actual concept is a time qualification that is not fixed and may be variable in nature. The variation may be highly predictable (such as dusk or dawn), or defined by external factors and authorities (such as school terms times in a specific locality). Hence in the D-TRO Data Specification we do not use the term 'Fuzzy Period', but rather 'ChangeableTimePeriod'.

Use of the ChangeableTimePeriodStart object and/or the ChangeableTimePeriodEnd object enable a Period to be defined using a variable date time start or end or both.

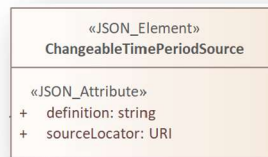
Figure 38 – UML model representation of the ChangeablePeriodStart Object**Figure 39 - UML model representation of the ChangeablePeriodEnd Object**

The ChangeableTimePeriodStart object (and the ChangeableTimePeriodEnd object) has one attribute:

- The mandatory 'startType' attribute (endType for the ChangeableTimePeriodEnd object), indicates the type of characteristic time measure being used. Values include: 'dawn', 'dusk', 'holiday', and 'external'.

Figure 40 provides the UML class representation of the ChangeableTimePeriodSource Object.

Figure 40 – UML model representation of the ChangeableTimePeriodSource Object

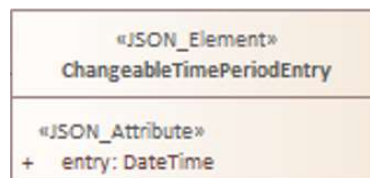


The ChangeableTimePeriodSource object has two mandatory attributes:

- The 'definition' attribute is a free-text string that describes the nature of the external data source.
- The 'sourceLocator' attribute is a URI hyperlink providing the accessible location for retrieval of the external data source.

Figure 41 provides the UML class representation of the ChangeableTimePeriodEntry Object.

Figure 41 – UML model representation of the ChangeableTimePeriodEntry Object



The ChangeableTimePeriodEntry object has one mandatory attribute:

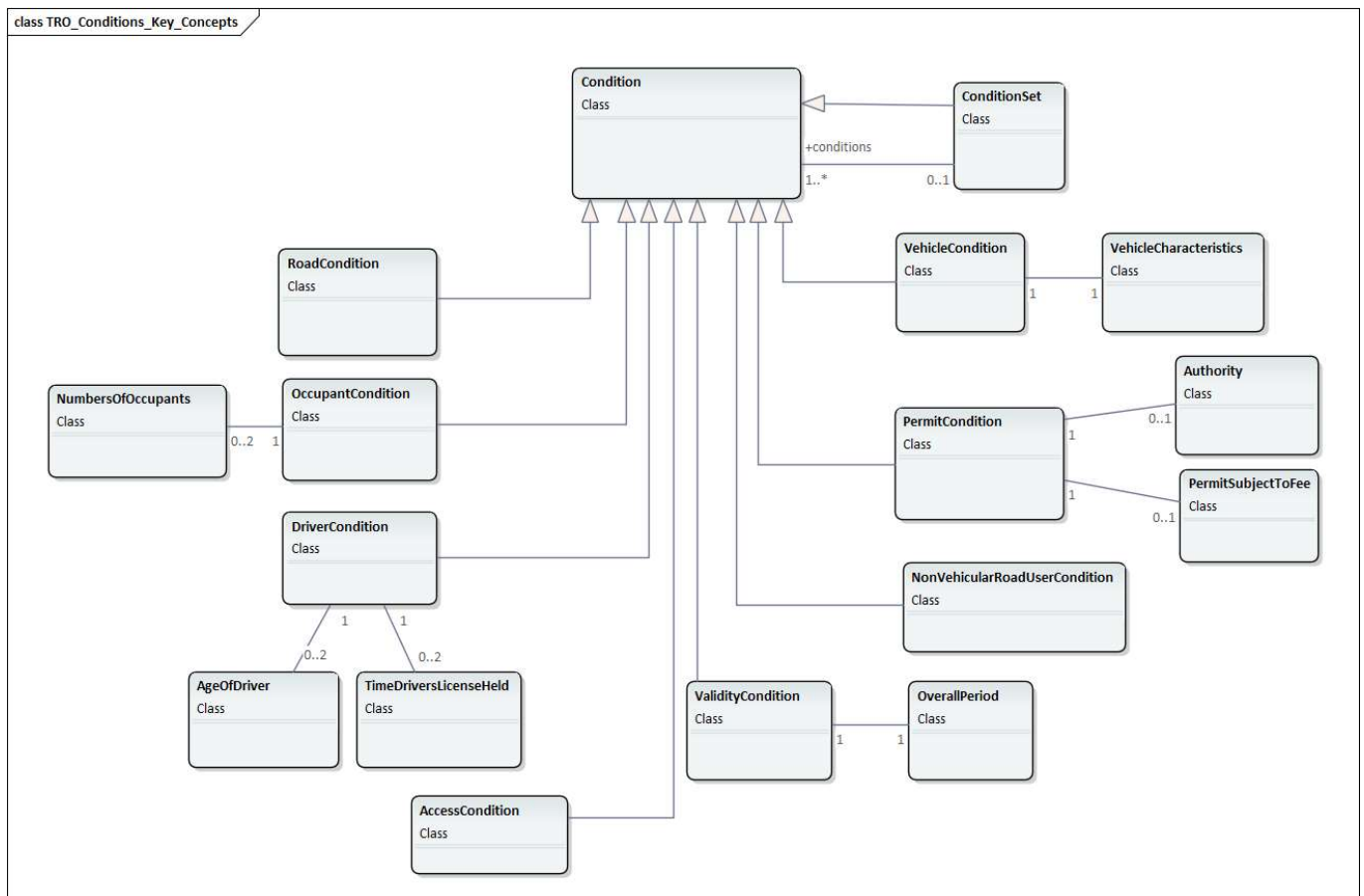
- The 'entry' attribute provides one date/time entry defining a specific date and time.

3.6. About Conditions and Exclusions

Being able to specify conditions that apply to regulations is a key element of D-TRO modelling. Such conditions enable regulation properties to detail, for example, width restrictions; access restrictions by vehicle type; conditions applied under different weather conditions, etc.

The D-TRO model for Conditions is used to specify conditions or constraints that apply to a Regulation. These include time period, vehicle type, weather conditions, etc.

Figure 42 provides the UML class representation of the Condition related objects.

Figure 42 - UML model representation of Condition related objects

To address complex conditions a ConditionSet object can be specified using a sequence of Conditions with logical operators specifying the relationship of the conditions. An example is as follows:

<ConditionSet operator = "OR">

<ConditionSet operator = "AND" >

<TimeCondition.../>

<VehicleCondition.../ >

</ConditionSet>

<ConditionSet operator = "AND" >

<TimeCondition.../ >

<VehicleCondition.../ >

</ConditionSet>

</ConditionSet>

Or, the same example in an alternate notation:

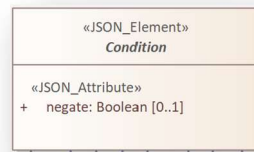
((TimeCondition and VehicleCondition) or (TimeCondition and VehicleCondition))

A condition stating VehicleType = EmergencyVehicle and negate = true would mean all vehicles except those of type EmergencyVehicle.

An unset negate value means the same as false, i.e., no negation applied.

Figure 43 provides the UML class representation of the Condition Object.

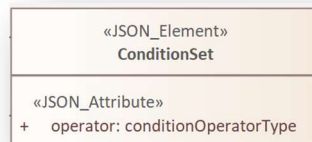
Figure 43 - UML model representation of the Condition Object



The **Condition** object has only the 'negate' attribute, as explained above.

Figure 44 provides the UML class representation of the ConditionSet Object.

Figure 44 - UML model representation of the ConditionSet Object

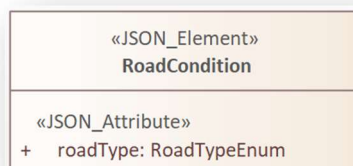


The **ConditionSet** object has only the 'operator' attribute, as explained above.

The operator attribute supports the permissible values 'and', 'or' and 'xor'.

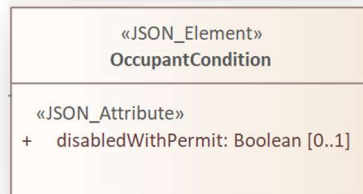
Figure 45 provides the UML class representation of the RoadCondition Object.

Figure 45 - UML model representation of the RoadCondition Object



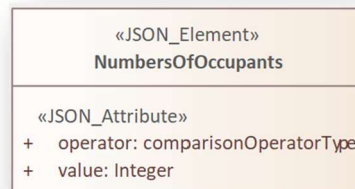
The RoadCondition object contains only the roadType attribute. Permissible values include: 'motorway', 'trunkRoad', and 'other'.

Figure 46 provides the UML class representation of the OccupantCondition Object.

Figure 46 - UML model representation of the OccupantCondition Object

The OccupantCondition object contains only the 'disabledWithPermit' attribute which is defined as a Boolean data type.

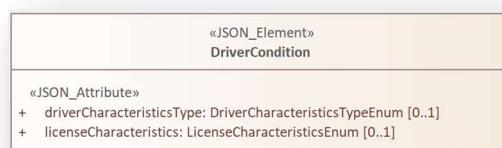
Figure 47 provides the UML class representation of the NumberOfOccupants Object.

Figure 47 - UML model representation of the NumberOfOccupants Object

The 'NumberOfOccupants' object has two mandatory attributes:

- The 'operator' attribute specifies operator to be used in the characteristic comparison operation. Permissible operators include 'equalTo', 'greaterThan', 'greaterThanOrEqualTo', 'lessThan', and 'lessThanOrEqualTo'.
- The 'value' attribute provides the integer numeric value for the boundary condition.

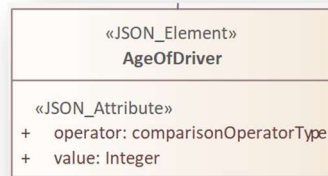
Figure 48 provides the UML class representation of the DriverCondition Object.

Figure 48 - UML model representation of the DriverCondition Object

The 'DriverCondition' object has two optional attributes:

- The 'driverCharacteristicsType' attribute indicates a specific type of driver characteristic. Permissible values include 'disabledWithPermit', 'learnerDriver', 'localResident', etc.
- The 'licenseCharacteristics' attribute indicates a characteristic relating to the driver's license. Permissible values include 'permanent', 'provisional'.

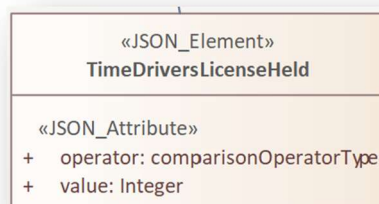
Figure 49 provides the UML class representation of the AgeOfDriver Object.

Figure 49 - UML model representation of the AgeOfDriver Object

The 'AgeOfDriver' object has two mandatory attributes:

- The 'operator' attribute specifies operator to be used in the characteristic comparison operation. Permissible operators include 'equalTo', 'greaterThan', 'greaterThanOrEqualTo', 'lessThan', and 'lessThanOrEqualTo'.
- The 'value' attribute provides the integer numeric value for the boundary condition.

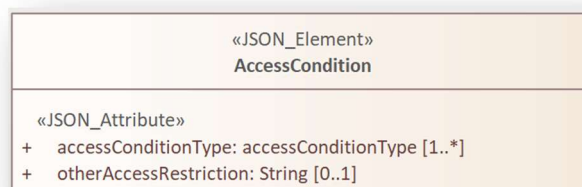
Figure 50 provides the UML class representation of the TimeDriversLicenseHeld Object.

Figure 50 - UML model representation of the TimeDriversLicenseHeld Object

The 'TimeDriversLicenseHeld' object has two mandatory attributes:

- The 'operator' attribute specifies operator to be used in the characteristic comparison operation. Permissible operators include 'equalTo', 'greaterThan', 'greaterThanOrEqualTo', 'lessThan', and 'lessThanOrEqualTo'.
- The 'value' attribute provides the integer numeric value for the boundary condition.

Figure 51 provides the UML class representation of the AccessCondition Object.

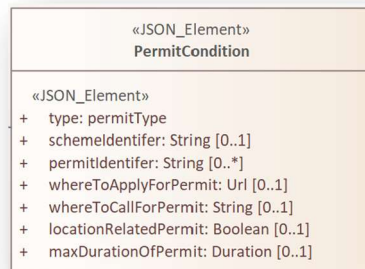
Figure 51 - UML model representation of the AccessCondition Object

The 'AccessCondition' object has two attributes:

- The 'accessConditionType' attribute indicates an access restriction type. Permissible values include 'accessOnly', 'loadingAndUnloading', 'throughTraffic', etc.
- The 'otherAccessRestriction' attribute indicates a condition controlling access.

Figure 52 provides the UML class representation of the PermitCondition Object.

Figure 52 - UML model representation of the PermitCondition Object

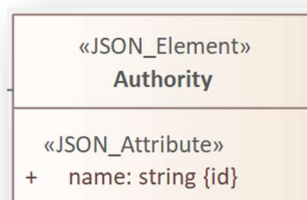


The 'PermitSubjectToFee' object has seven attributes:

- The mandatory 'type' attribute indicates the type of the referenced permit. Permissible values include: 'doctor', 'business', 'resident', 'other'.
Note: the permissible values list is under review and may modify in future releases of the Data Model.
- The optional 'schemeIdentifier' attribute supports a free text name for the permit scheme referenced.
- The optional 'permitIdentifier' attribute supports multiple instances for an identifier for the permit scheme referenced (e.g., resident parking zone A).
- The optional 'whereToApplyForPermit' attribute provides a web address (URL) of the competent authority where an application for a permit can be requested.
- The optional 'whereToCallForPermit' attribute provides a contact telephone number of the competent authority where an application for a permit can be requested.
- The optional 'locationRelatedPermit' Boolean attribute which indicates if the referenced permit related to a specified geography.
- The optional 'maxDurationOfPermit' attribute which indicates the maximum validity duration a permit can have, specified in hours.

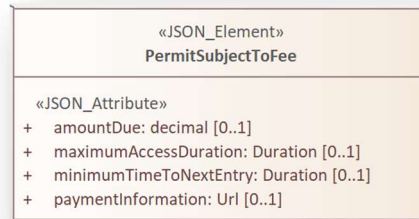
Figure 53 provides the UML class representation of the Authority Object which is linked to PermitCondition.

Figure 53 - UML model representation of the Authority Object



The 'Authority' object has only one attribute – The 'name' attribute indicates an access restriction type. Permissible values include 'accessOnly', 'loadingAndUnloading', 'throughTraffic', etc.

Figure 54 provides the UML class representation of the PermitSubjectToFee Object which is linked to PermitCondition.

Figure 54 - UML model representation of the PermitSubjectToFee Object

The 'PermitSubjectToFee' object has four optional attributes:

- The 'amountDue' attribute indicates the monetary amount, in pounds sterling, related to use of or purchase of permit. Expressed as a decimal.
- The 'maximumAccessDuration' attribute expresses the maximum duration that is permitted in relationship to use of this permit.
- The 'minimumTimeToNextEntry' attribute expresses the minimum duration between last use of permit and next permitted use of permit. This is often referred to as the no return time.
- The 'paymentInformation' attribute provides a web address (URL) for further information on permit and related payment.

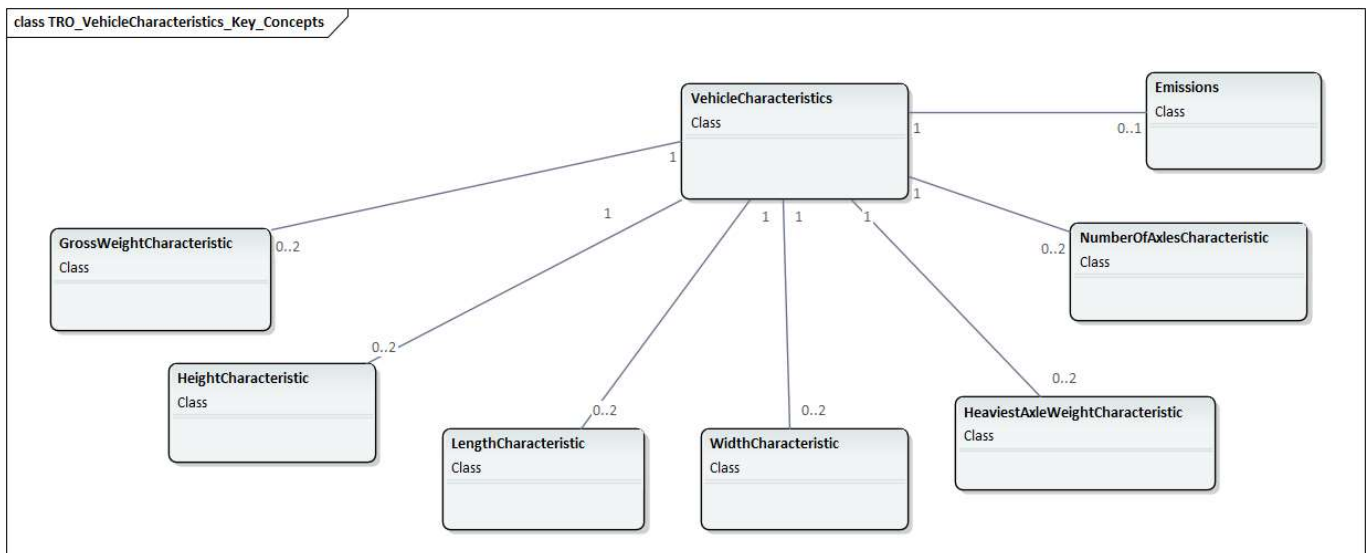
The Condition object is linked to the ValidityCondition object, which in turn provides a link to the 'standard' Validity sub-model (OverallPeriod object at the top of this sub-model). This enables time-related conditions to be specified.

3.7. Specifying Vehicle Conditions

The VehicleCharacteristics-related objects, specified in this section, comprise a sub-model for defining the characteristics of vehicles.

The information that is modelled in VehicleCharacteristics objects identifies a set of vehicle characteristics, many of whose values can be specified using comparative operators (e.g., greater than 'x' but less than 'y'). For example, a structural width limit on a bridge may specify the WidthCharacteristic as being less than 2.0 metres, by setting the vehicleWidth attribute value to "2.0" and the related comparisonOperator to "lessThanOrEqualTo".

Figure 56 provides the UML class representation of the VehicleCharacteristics-related objects.

Figure 55 - UML model representation of VehicleCharacteristics related objects

The objects GrossWeightCharacteristic, HeightCharacteristic, LengthCharacteristic, WidthCharacteristics, HeaviestAxleWeightCharacteristic and NumberOfAxesCharacteristic all follow the same basic pattern, which is described below.

We will use the GrossWeightCharacteristic object to illustrate this pattern. The GrossWeightCharacteristic enables limits for gross weight to be defined. If gross weight limits are defined in theory there could be two limits – an upper bound (maximum weight) and a lower bound (minimum weight), as show in Figure 56.

In practice, upper bounds are specified in TROs.

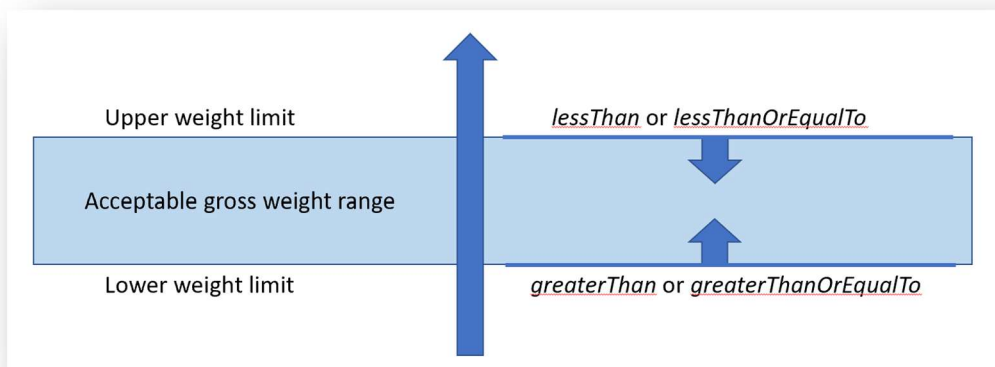
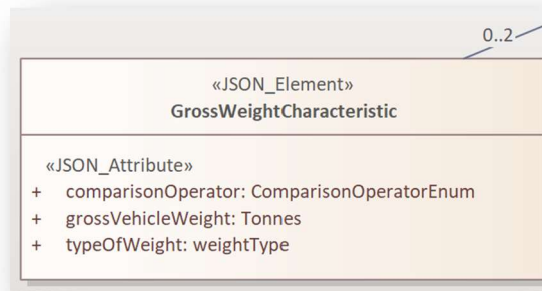
Figure 56 - Example of boundary conditions (upper and lower bounds)

Figure 58 provides the UML class representation of the GrossWeightCharacteristic Object, to support the potential for both upper and lower bounds to be specified up to two instances, depicted by the [0..2] in the UML representation, of GrossWeightCharacteristics can be linked to each instance of VehicleCharacteristics.

Figure 57 - UML model representation of the GrossWeightCharacteristic Object

The GrossWeightCharacteristic object has three attributes:

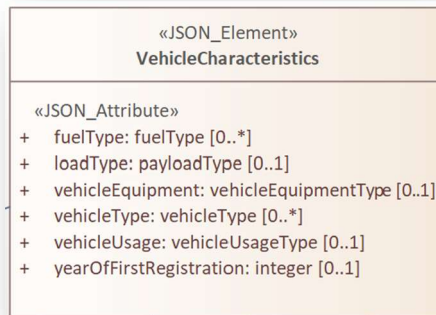
- The mandatory 'comparisonOperator' attribute specifies the operator to be used in the vehicle characteristic comparison operation. Permissible operators include 'equalTo', 'greaterThan', 'greaterThanOrEqualTo', 'lessThan', and 'lessThanOrEqualTo'.
- The mandatory 'grossVehicleWeight' attribute provides the numeric value for the boundary condition. It is specified in Tonnes.
- The mandatory 'typeOfWeight' attribute identifies different forms of weight limit that may be specified. Permissible weight types include 'actual', 'combinedMaximumPermitted', 'maximumPermitted', 'unladen'.

This pattern is replicated as follows:

Object	Numeric attribute	Unit	Numeric type
GrossWeightCharacteristic	grossVehicleWeight	Tonnes	Float
HeightCharacteristic	vehicleHeight	Metres	Float
LengthCharacteristic	vehicleLength	Metres	Float
WidthCharacteristics	vehicleWidth	Metres	Float
HeaviestAxleWeightCharacteristic	heaviestAxleWeight	Tonnes	Float
NumberOfAxlesCharacteristic	numberOfAxles		Integer

Attributes similar to 'typeOfWeight' are not replicated in the other objects listed.

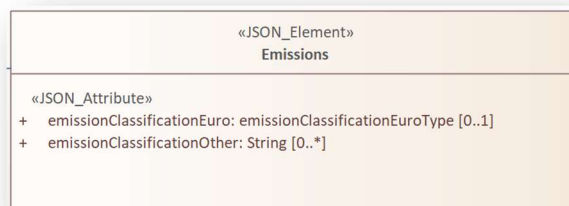
Figure 58 provides the UML class representation of the VehicleCharacteristics Object.

Figure 58 - UML model representation of the VehicleCharacteristics Object

The VehicleCharacteristics object has six optional attributes:

- The 'fuelType' attribute specifies optionally multiple fuel types used by vehicles, within this condition. Permissible fuel types include 'petrol', 'diesel', 'hydrogen', 'lpg', 'battery', etc.
- The 'loadType' attribute specifies optionally one type of load carried by the vehicle. Permissible load types include 'empty', 'dangerousGoods', 'explosiveMaterials'.
- The 'vehicleEquipment' attribute specifies optionally one type of vehicle equipment. Permissible equipment types include 'snowChainsInUse', 'dippedHeadlightsInUse', 'electronicTollEquipment', etc.
- The 'vehicleType' attribute specifies optionally multiple types of vehicle. Permissible vehicle types include 'taxi', 'pedalCycle', 'car', 'goodsVehicle', 'bus', etc.
- The 'vehicleUsage' attribute specifies optionally one usage type (i.e., for what purpose is the vehicle being used). Permissible vehicle usage types include 'accessToOffStreetPremises', 'localBuses', 'privateHireVehicle', 'guidedBus', etc.
- The 'yearOfFirstRegistration' attribute specifies optionally one registration year. Year is specified as an integer in the format YYYY (e.g. 2008).

Figure 59 provides the UML class representation of the Emissions Object.

Figure 59 - UML model representation of the Emissions Object

The Emissions object has two optional attributes:

- The 'emissionClassificationEuro' attribute specifies the minimum Euro emission classification the vehicle(s) have to comply with according to the 1970 Directive 70/220/EEC and its several amendments.

To specify emissionClassificationEuro properly, it is necessary to define:

- the corresponding vehicle type (e.g., car for M1, miniBus for M2, lightCommercialVehicle for N1 or largeGoodVehicle for N2)
- and fuel type (e.g., diesel for CI engines or petrol for PI engines)

in the vehicleCharacteristics object.

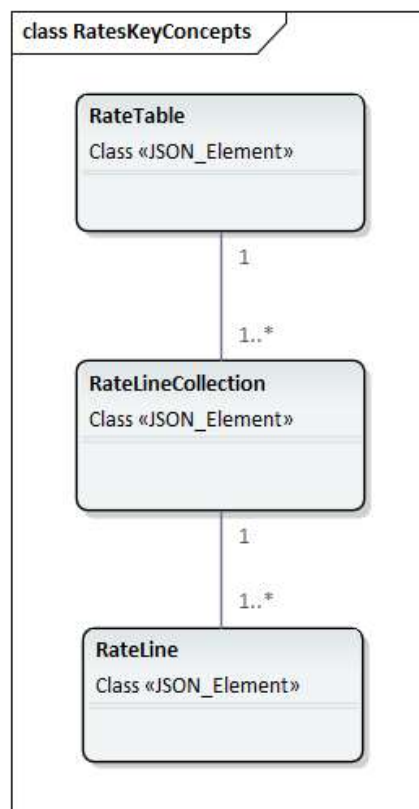
Note that Euro V and Euro VI are used for emissions of lorries only.

- The 'emissionClassificationOther' attribute specifies optionally multiple free-text description of a classification type for vehicle emissions, distinct from the Euro classifications.

3.8. About Tariff Rates

Figure 60 provides the UML class representation of the Rate-related objects.

Figure 60 - UML model representation of Rate-related objects



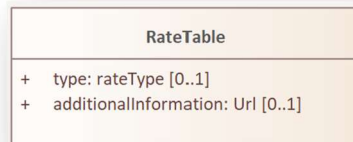
Information concerning tariff rates may be associated with a defined **Condition**.

The Rates sub-model shown here is experimental. It is derived from a richer model that has been specified within the APDS⁸ specifications which have been published as an ISO Technical Specification ISO TS 5206-1:2023.

Note: The previous DfT Alpha project prototyping begun examining whether this Rates sub-model has sufficient functionality to meet the needs of describing rates and tariff in D-TROs. Further work during the Beta Project testing is needed.

Figure 61 provides the UML class representation of the RateTable Object. Each instance of the **Condition** object may optionally be linked to one instance of the **RateTable** object. A RateTable is described as specific set of rate charges relating to one or more locations and one set of condition criteria.

⁸ APDS – the Alliance for Parking Data Standards – see <https://www.allianceforparkingdatastandards.org/>

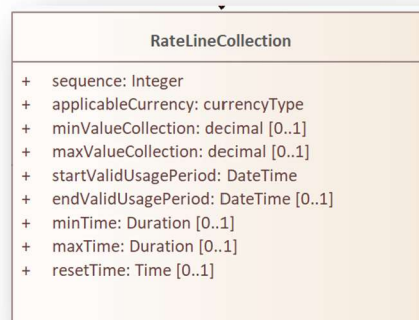
Figure 61 - UML model representation of the RateTable Object

The **RateTable** object has two optional attributes:

- The 'type' attribute specifies the type of rate in use. Permissible types are: 'daily', 'hourly'.
- The 'additionalInformation' attribute provides a web address (URI) locator for supplementary additional information concerning use of the rate table.

Each **RateTable** object contains one or more **RateLineCollection** objects. A **RateLineCollection** is defined as group of rate line elements that logically group together within one rate table, e.g., such as the rate lines for the different tiers of a time-based tier rate table.

Figure 62 provides the UML class representation of the **RateLineCollection** Object.

Figure 62 - UML model representation of the RateLineCollection Object

The **RateLineCollection** object has the following attributes:

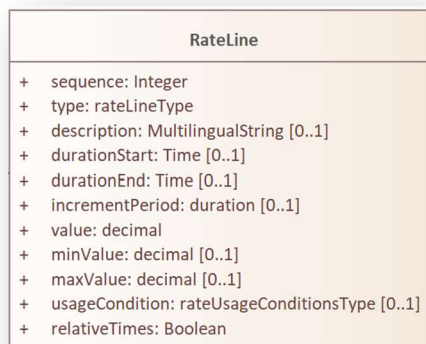
- The mandatory 'sequence' attribute which is specified as an incrementing integer which is an indicator giving the place in sequence of this rate line collection within the **RateTable**.
- The mandatory 'applicableCurrency' attribute which defines the monetary currency that rates are specified in this rate line collection. Permissible values are: 'GBP', 'EUR'.
- The optional 'minValueCollection' attribute which defines the minimum monetary amount to be applied in conjunction with use of this rate line collection. Specified as a decimal.
- The optional 'maxValueCollection' attribute which defines the maximum monetary amount to be applied in conjunction with use of this rate line collection. Specified as a decimal.
- The mandatory 'startValidUsagePeriod' attribute which defines the start time for the validity of this rate line collection.
- The optional 'endValidUsagePeriod' attribute which defines the end time for the validity of this rate line collection.
- The optional 'minTime' attribute which defines a minimum session duration to be applied to this rate line collection.

- The optional 'maxTime' attribute which defines a maximum session duration to be applied to this rate line collection.
- The optional 'resetTime' attribute which defines the time that rate resets. Example: a rate table that charges £2 per hour with a max value collection of £10, resets at 2 am. At 2 am, the £2 per hour fee would start to charge until the £10 is reached.

Each **RateLineCollection** object contains one or more **RateLine** objects.

Figure 63 provides the UML class representation of the RateLine Object. A RateLine is defined as a specific rate element of a rate line collection within a specific rate table.

Figure 63 - UML model representation of the RateLine Object



The RateLineCollection object has the following attributes:

- The mandatory 'sequence' attribute which is specified as an incrementing integer which is the ordered sequence of this RateLine instance within the RateLineCollection. Used to define the order of operation of multiple rate lines.
- The mandatory 'type' attribute which indicates the nature of the rate line. Permissible values are: 'flatRate', 'incrementingRate', 'flatRateTier', 'perUnit'.
- The optional 'description' attribute which provides a free-text description associated with this rate line.
- The optional 'durationStart' attribute, which indicates the start time for the applicability of the specific rate line, generally with respect to the start of the parking or other mobility session. e.g., the start of a time-based tier charge rate.
- The optional 'durationEnd' attribute, which indicates the end time for the applicability of the specific rate line, generally with respect to the start of the parking or other mobility session. e.g., the end of a time-based tier charge rate.
- The optional 'incrementPeriod' attribute, the time period for incrementing the rate line charge. If set to the same as the duration of the period between the durationStart and durationEnd the increment will occur once per period, i.e., a flat rate time-based tier charge rate.
- The mandatory 'value' attribute which indicates the value of the fee to be charged in respect of this rate line.
- The optional 'minValue' attribute which is the minimum monetary amount to be applied in conjunction with use of this rate line collection, regardless of the actual calculated value of the rate line.

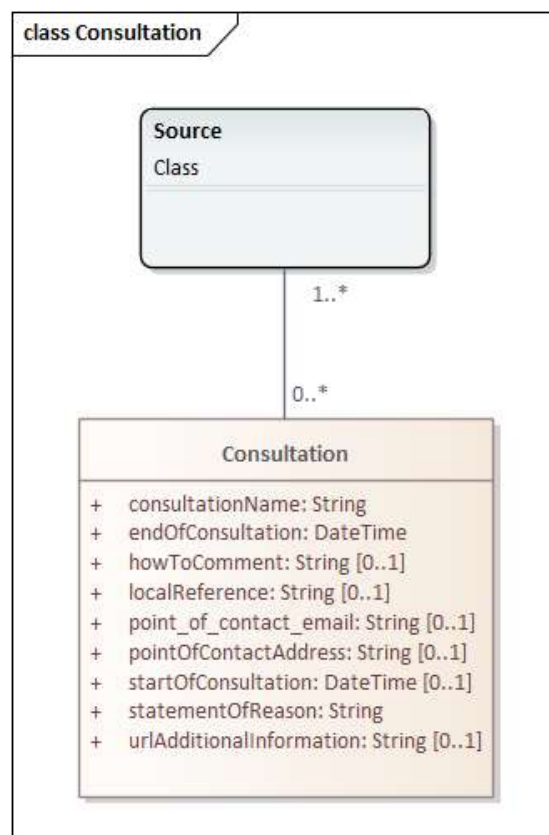
- The optional 'maxValue' attribute which is the maximum monetary amount to be applied in conjunction with use of this rate line collection, regardless of the actual calculated value of the rate line.
- The optional 'usageCondition' attribute which indicates conditions on the use of this rate line. Permissible values are: 'fixedDuration', 'fixedNumber', 'once', 'unlimited'.

3.9. About Consultations

This section of the Data Model is designed to permit basic information relating to a consultation to be coded and exchanged.

Figure 64 provides the UML class representation of the Consultation related objects.

Figure 64 – UML model representation of Consultation related objects



The Consultation object has numerous attributes:

- The mandatory 'consultationName' attribute enables the TRA to the published name for this TRO under consultation.
- The mandatory 'endOfConsultation' date / time indicating the end of the Consultation period.
- An optional free-text string with the 'howToComment' attribute specifying how to comment on the proposal which is the subject of the consultation.
- An optional free-text string with the 'localReference' attribute for an identifier for the consultation defined by the Local Authority.
- An optional free-text string with the 'point_of_contact_email' attribute giving the email address location to support receipt of comments / objections to consultation proposals.
- An optional free-text string with the 'pointOfContactAddress' attribute giving the postal or office address location to support receipt of comments / objections to consultation proposals.

- An optional date / time field with the 'startOfConsultation' attribute giving time and date of the start of the consultation period.
- An optional free-text string with the 'statementOfReason' attribute giving the Statement of Reason.
- An optional free-text string with the 'urlAdditionalInformation' attribute giving the web address (URL) for where to find further information related to the consultation.

3.10. Extending the Data Model

The D-TRO data model (and associated schema) defines categorised lists of short name terms that represent different concepts and choices. Examples of these lists include regulation type, vehicle type, permit type, etc.

It is intended that the D-TRO data model covers a broad spectrum of choices covering a vast majority of TROs to be produced in the future.

Future Statutory Guidance and best practice documentation will strongly encourage reuse of standardised concepts. However, it is prudent that the data model also supports the ability to define new or unusual concepts.

Therefore, the ability to support additional enumerations would be prudent for several of the enumerated lists existing in the data model. These include:

- regulationType
- permitType
- payloadType
- vehicleUsageType
- emissionsClassificationEuroType
- fuelType
- vehicleEquipmentType

To maintain the simplicity in the data model, it is easiest to add an "other" enumeration value to each of the enumerated lists stated.

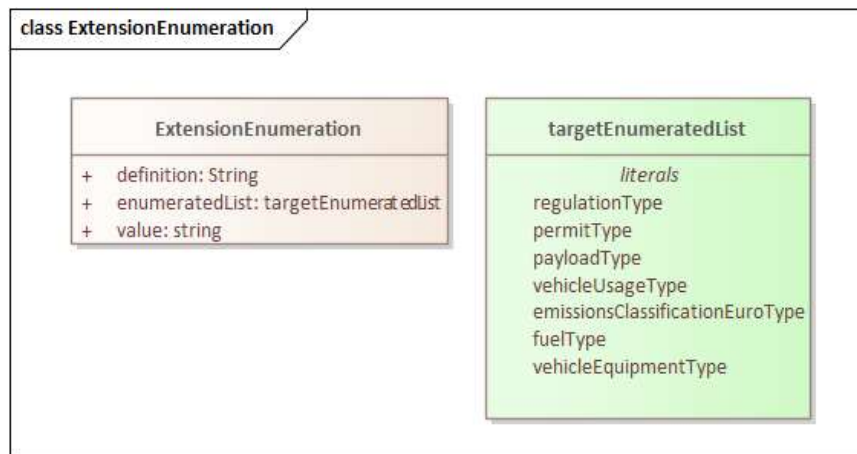
In instances where the "other" enumeration is used further information shall be required. In each case the user (the Local Authority) would be required to provide a unique enumeration short name (distinct from short names that appear in the data model) plus a robust definition.

The use of "other" on its own shall not be permitted.

Rather than adding this extension mechanism to each relevant enumerated list in the data model, a generic extension mechanism has been added to the model, which indicates:

- which list is being extended
- a short name enumerated value
- a complete definition for the enumeration

Figure 65 provides the UML class representation of the ExtensionEnumeration Object.

Figure 65 – UML model representation of the ExtensionEnumeration Object and related Enumeration

3.11. Live reporting of temporary TROs (TTROs)

Note: It is expected that a law, via secondary legislation, will require the 'real-time' reporting of occupation of the road (start and end) occurring under the auspices of a TTRO. For the D-TRO Beta project, foundational elements to the data model have been developed which will support future extension of Live reporting of TTROs.

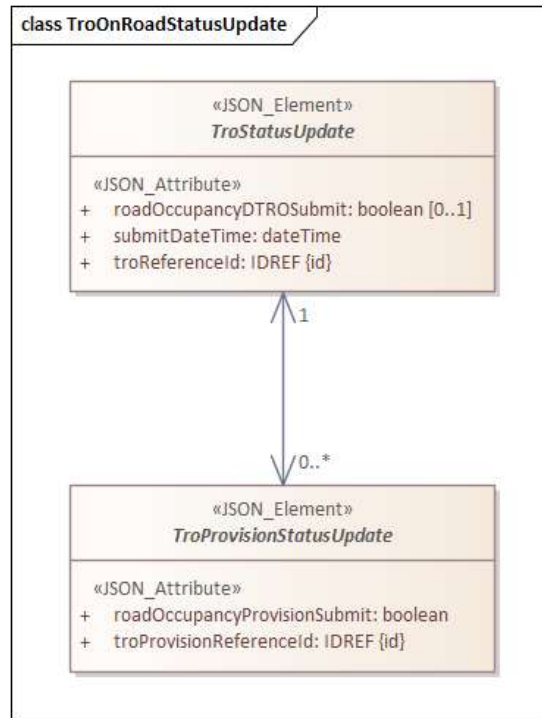
Temporary TROs (TTROs) can be made for period of up to 18 months. They are often made to enable full closures of roads or lane, or temporary speed limits, often in support of highway works or street (utility) works. TTROs are very common and numerous. Although the duration of a TTRO can be reduced to match the expected duration of the associated works. It may be pragmatic to set the period of the TTRO to be longer to permit operational flexibility in when works are carried out, and to also support overrunning works.

A TTRO, like other TROs, could contain multiple Provisions. Therefore, the capabilities to record 'real-time' starts and stops of occupancy could be recorded for a TTRO as a whole or for one of its Provisions. The wording concerning the timing and technical approach to recording and sharing data with the D-TRO Service is yet to be defined. The existing data model does not (yet) support this capability.

This data model includes the need to provide a lightweight mechanism to receive start and stop notifications. It is assumed the parent TTRO will be recorded and "active" (i.e. between its notional start datetime and end datetime) in the Central Service. With assigned IDs for the TTRO as a whole and also for any Provision it contains.

The current requirement is captured through the data model as follows:

- Start and Stop notices will be related to either the whole TTRO or a specified Provision of a TTRO.
- Records management should not (initially) be overly demanding and rigid, i.e. if a Stop notice is received it should not be rejected because no Start notice has been previously received. (to confirm)
- If a start or stop notice is received for a whole TTRO, it can be considered to overwrite the status of child Provisions.
- The real-time status of the whole TTRO or one to many of Provisions should be able to be set and varied.

Figure 66 – UML model representation of the TroOnRoadStatusUpdate Object

4. What is a 'full' D-TRO Record?

When a TRA submits a new D-TRO record care is required to ensure that the record contains all necessary information – this is the responsibility of the TRA. The D-TRO Service will undertake various forms of validation to ensure that requirements have been met and the D-TRO record can be accepted.

Note: The test of what constitutes a D-TRO record that contains all essential elements and therefore can be considered to be a 'full' record is subject to review and learning from prototyping. This section is therefore likely to change with new releases.

4.1. Validation Rules

Two primary forms of validation test are foreseen:

- Schema validation – this is a set of technical tests to ensure that the data and the structure of the submitted D-TRO record conforms to the requirements of the D-TRO Data Model and schema. These tests will check that mandatory elements of the Data Model exist in the D-TRO record; that the supplied data conforms to prescribed data types (e.g. if an attribute that the data contained with an attribute which is defined as a DateTime in the Data Model, is supplied data is a date time in an acceptable format), etc.
- Semantic validation – this is a further set of technical tests that the schema validated data meets further requirements. For example:
 - The mandatory 'ta' attribute of the Source object contains not only an Integer value, as required by schema validation, but the value given matches a value in the [SWA code list](#), that corresponds to the sender's TRA SWA code (e.g., '116' for Bristol City Council).

A set of validation tests have been created, which are summarised in the tables below. A detailed document of the validation rules are available on the GitHub [here](#).

Appropriateness related rules to help keep the data within the D-TRO service as relevant as possible and does not contain biases, which make them unfit for use by the Software Providers.

Rule Type	Description
Nature of business rules	Some TRO data will apply to specific consumer types or across different consumers. Selection and use of the right set of data ensures that it is relevant for each user type and provided in the appropriate way.
Entity-status relationships	Provisions cannot be linked to TROs if the status of one is inappropriate.
Currency rules	Appropriate currencies and timing considerations are used.
Retention rules	Record is retained for X period after trigger Y. E.g. keep inactive TROs for max. 3 years from time of becoming inactive.
Data consistency	TROs that are duplicated (for performance, redundancy, etc) should be consistent with the original values, and be subject to the same domain and data quality rules.

Completeness rules ensures that the data model provides comprehensive information for the digitalisation and analysis of TROs.

Rule Type	Description
Entity completeness	The full set of entities are present, i.e. all TRO records with provisions are present
Relationship completeness	Referential integrity is correct between TROs and provisions i.e. all relationships between entities can be resolved.
Attribute completeness	All required attributes for TRO entities are present i.e. all necessary columns are populated
Domain completeness	All required attributes contain an allowable value, and intentionally set nulls can be differentiated from absent values
Identity / uniqueness rules	Every TRO record must exist only once, be uniquely identifiable, relate to exactly one real world entity with attributes not being overloaded – e.g. containing different regulation types in a single field
Entity-relationship constraints	The existence of one relationship mandates or prohibits the existence of another, e.g. an “Amend” or “Revoke” provision must be linked to an existing DTRO record.
Attribute-relationship constraints	The allowable values of one or more values mandates or prohibits the value (or existence) of another, e.g. A vehicle dimension populated for a size-based restriction.
Event-relationship constraints	Links that must exist for an instance to occur, e.g. activation / inactivation of a temp TRO must have an existing TRO present.
Optionality constraints	Attributes have defined list of options to populate with, e.g. the Speed Limit value.
Inheritance rules	Existence of all necessary fields from combination of super-type and sub-type. Correct application of implied rules through sub-typing, e.g. activation notices for temp TROs.
Granularity rule	Historic data is kept for the same period at similar level of granularity.
Continuity rule	No gaps or overlaps in historic or time series data for DTROs, e.g. contradictory time ranges for overlapping TROs.
Event dependencies	Relating separate events that are likely to be consistent in time, e.g. connection between consultation and the provision of an active TRO.

Accuracy related rules ensure the degree of confidence that can be placed in the data from the D-TRO service. Data must be sufficiently accurate as standardised data to support the defined use cases and avoid material distortion in the central storage system.

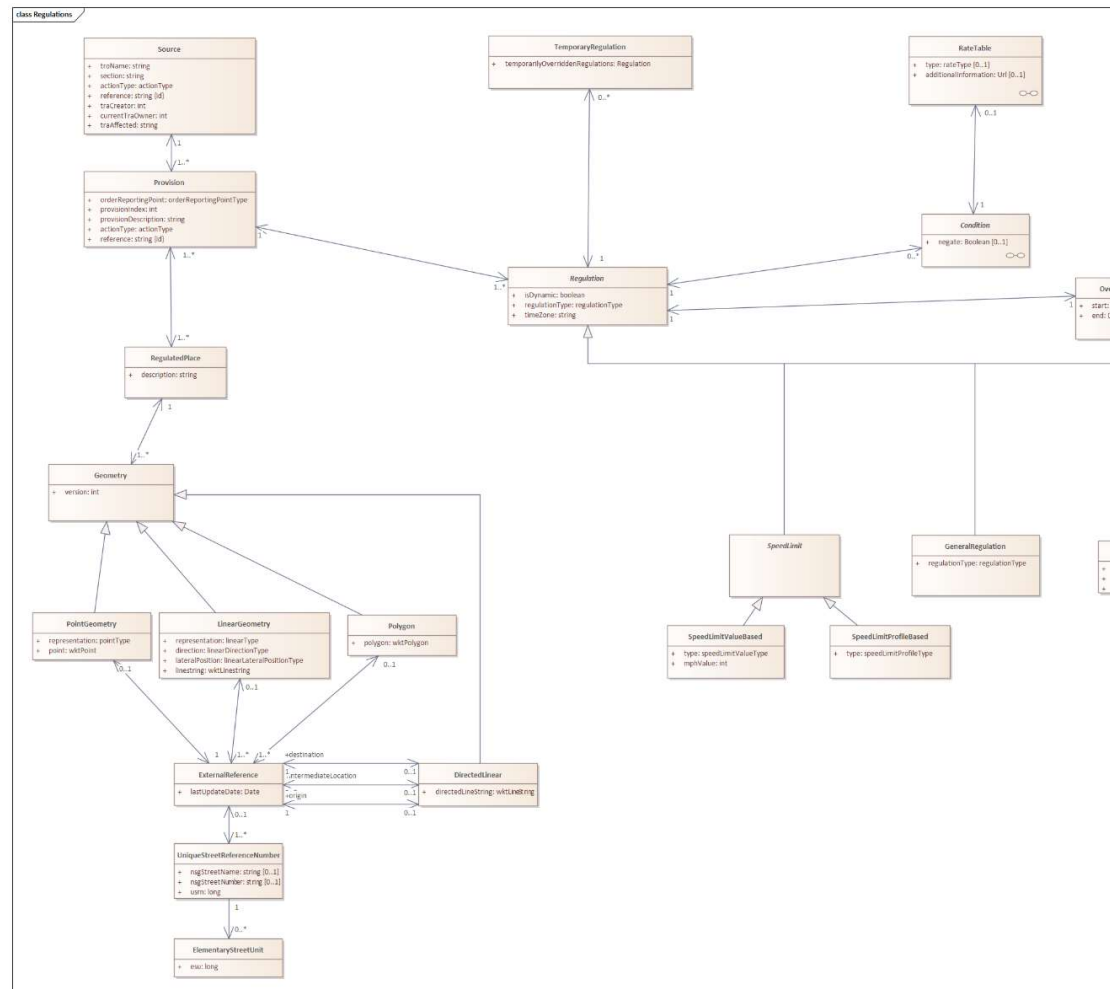
Rule Type	Description
Data accuracy	An attribute must be representative of its real-world state as per the TRO.
Valid value constraints	A list of values, a range of values, a constraint on values, a set of allowable characters as part of the DTRO.
Format constraints	For DateTime, Values, Geographical Coordinates and other specific formats for fields.
Precision constraints	The values in the field must be the same precision as the attribute requires in response to DTRO requirements, business rules and intended meaning, e.g. vehicle dimensions.
Definition constraints	The values match the intended meaning of the attribute, e.g. coordinate type reflects the value of coordinates entered.
Attribute constraints	One attribute can be derived from one, two, three or more others, e.g. parking duration restrictions.

Rule Type	Description
Timestamp pattern rule	Ensuring dates and times are within correct ranges.
Reference rule	Ensure a reference system is implemented at each TRA level for tracking previous changes done to its DTROs
Action rule	Each DTRO must have one action at the source and provision level provided by the TRA that issues the DTRO.

5. D-TRO Data Model UML Class Diagrams

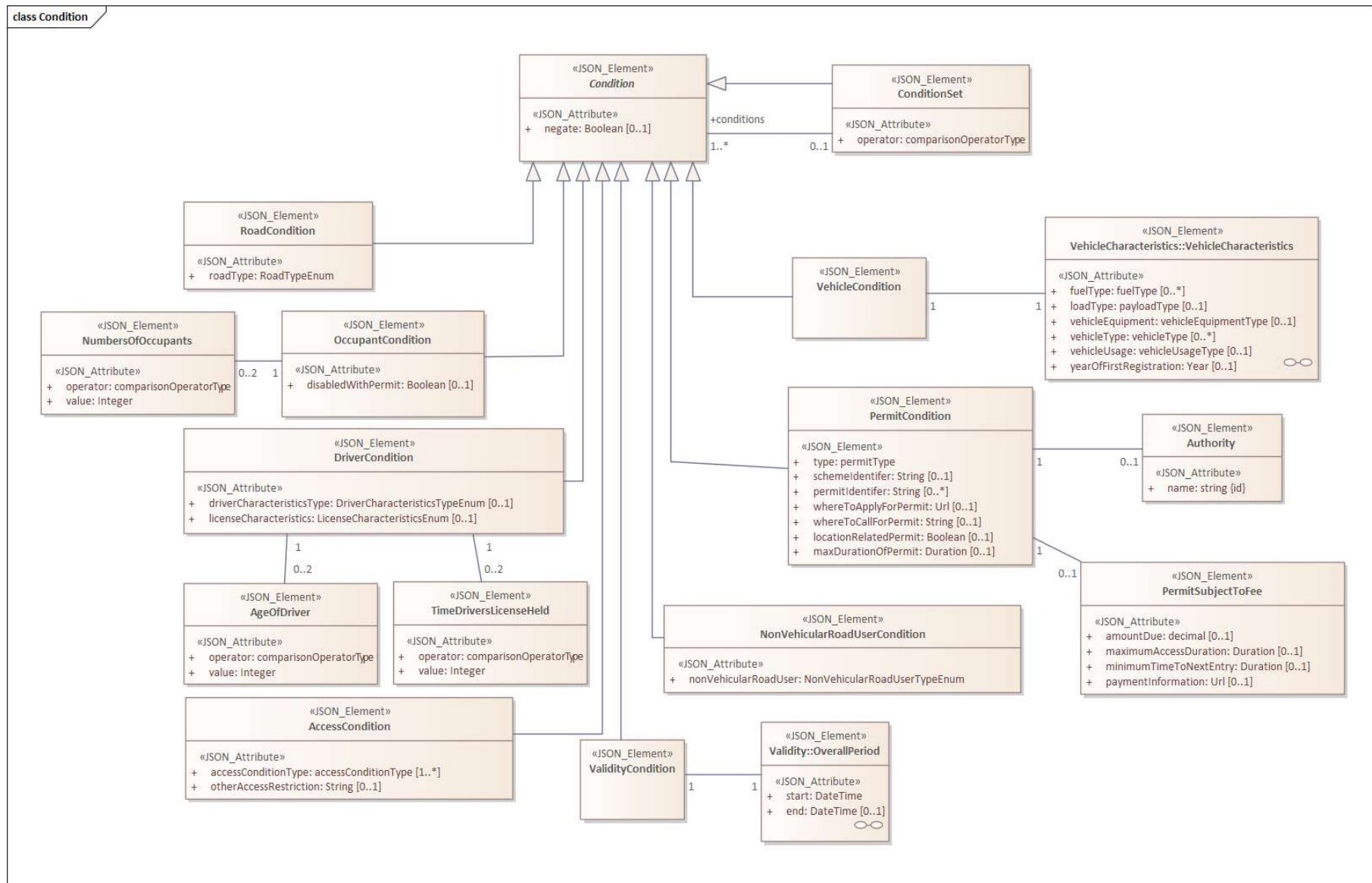
This section presents UML class diagrams for the full content of the D-TRO Data Model.

Figure 67 – UML class diagram – high-level full D-TRO model



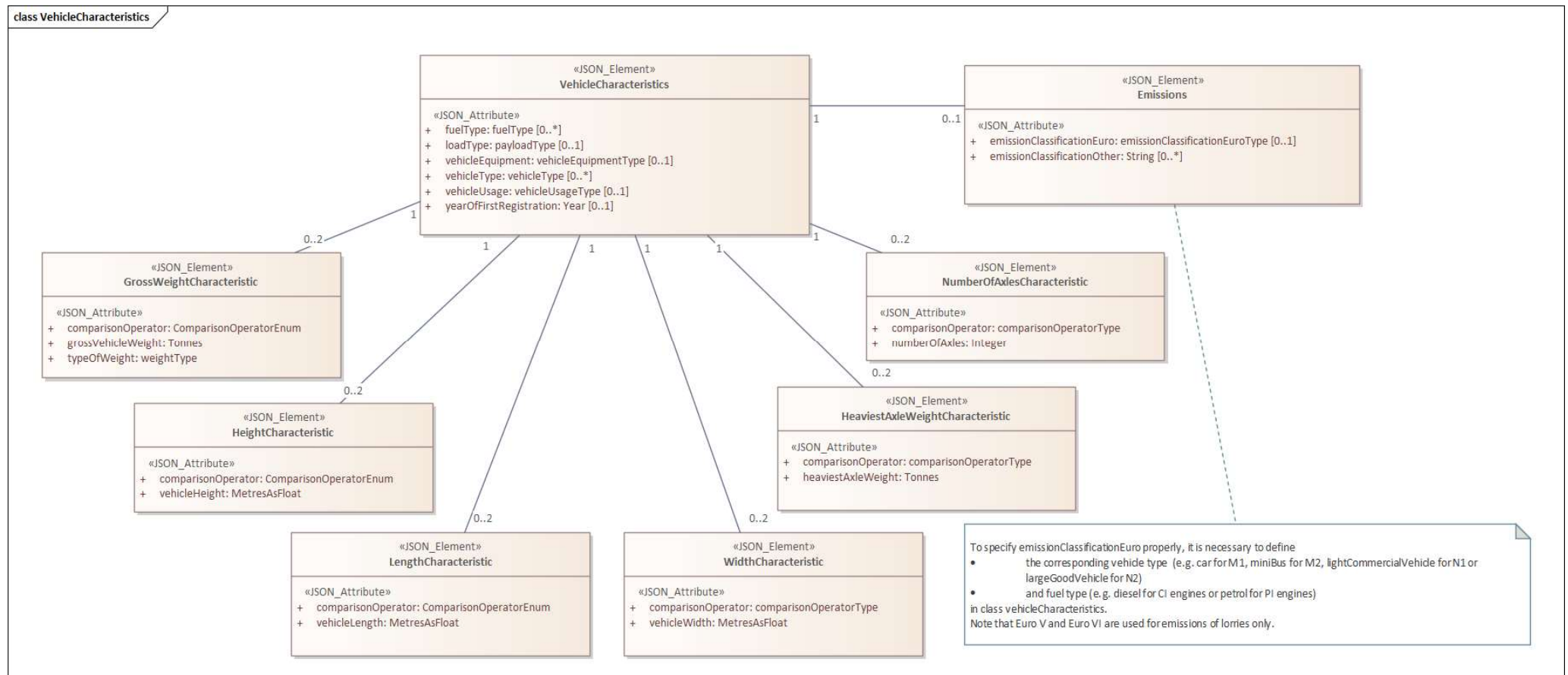
"Condition" sub-model

Figure 68 – UML class diagram – Condition sub-model



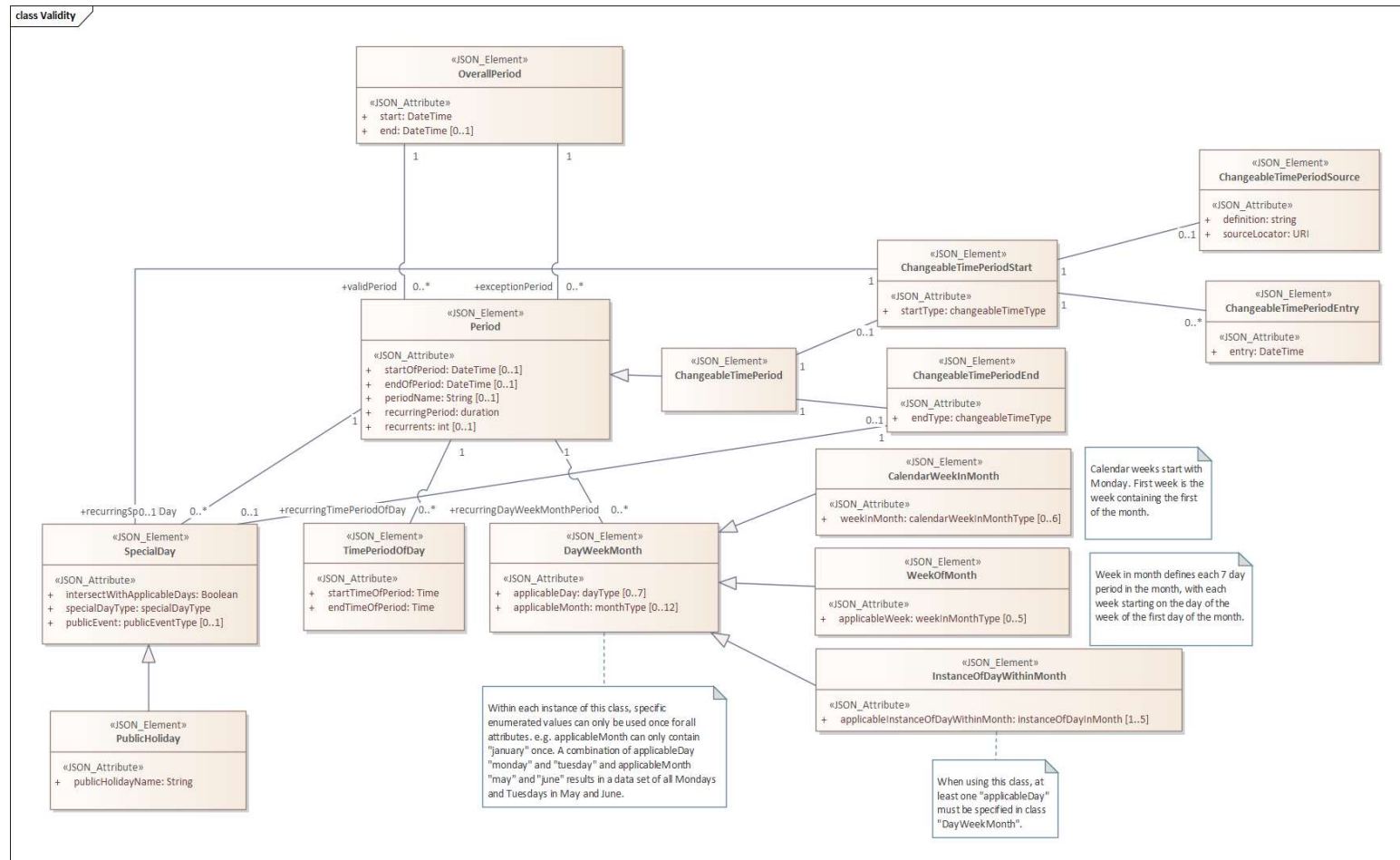
"VehicleCharacteristics" sub-model

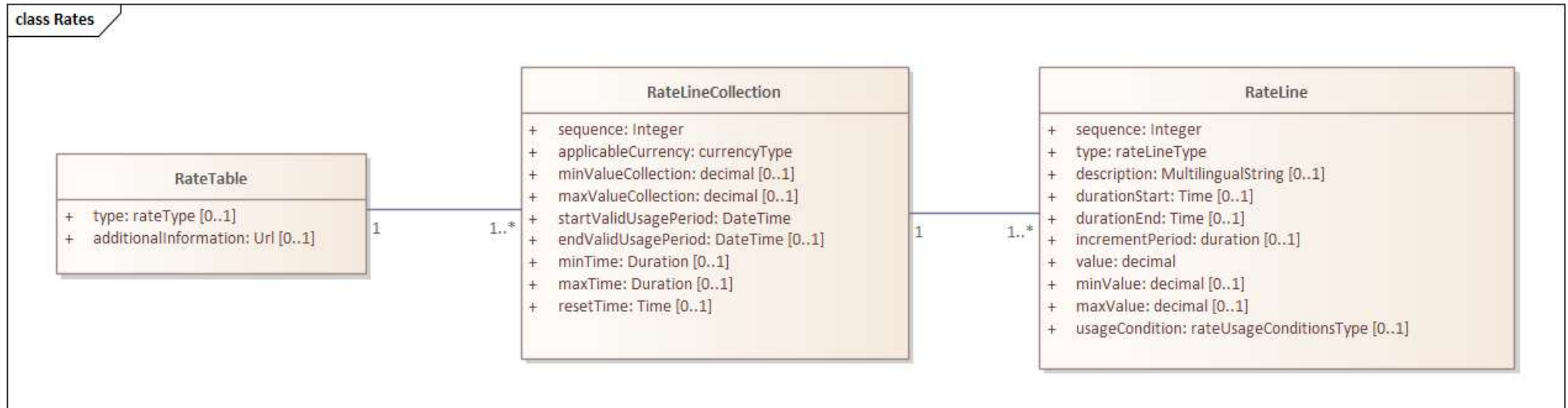
Figure 69 – UML class diagram – VehicleCharacteristics sub-model

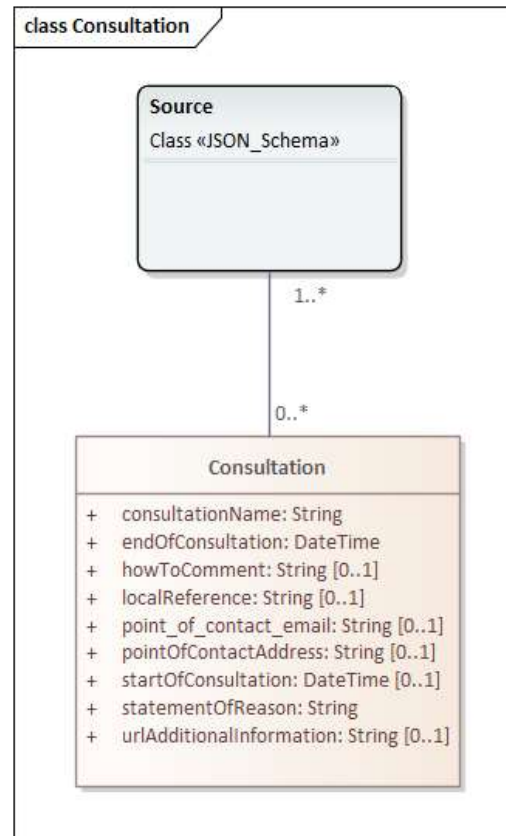


"Validity" sub-model

Figure 70 – UML class diagram – Validity sub-model



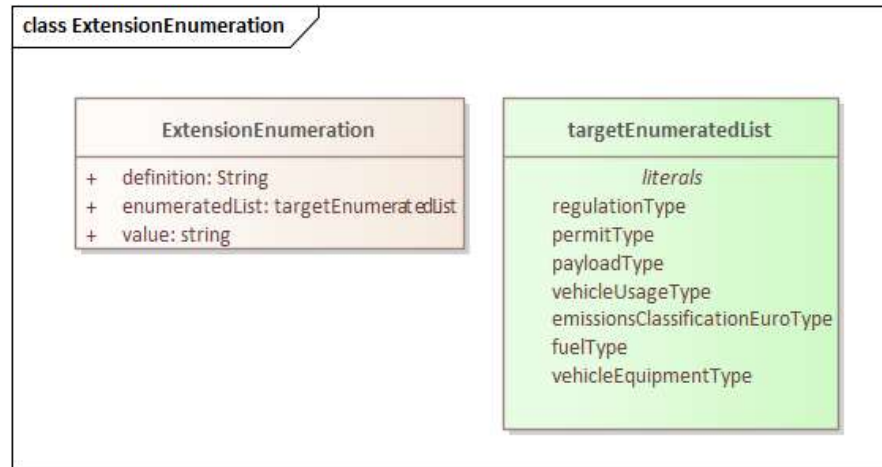
"Rate" sub-model*Figure 71 – UML class diagram – Rate sub-model*

"Consultation" sub-model**Figure 72 – UML class diagram – Consultation sub-model**

"ExtensionEnumeration" sub-model

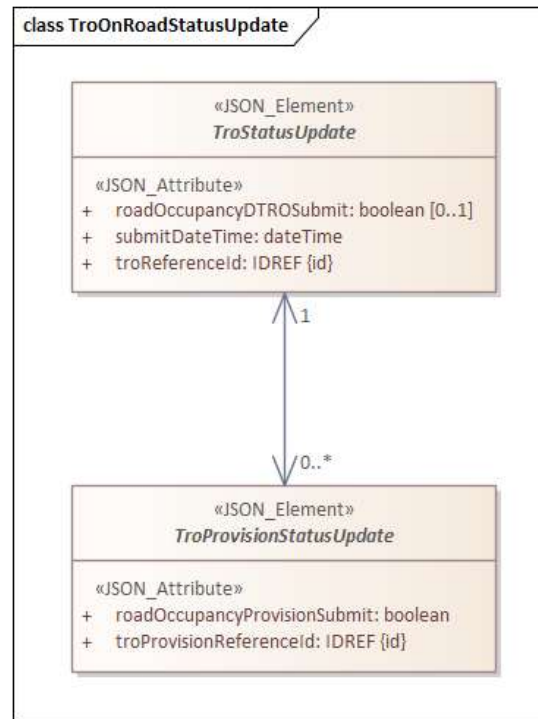
This sub-model enables user-defined extensions to the main enumeration lists found in the data model (see targetEnumeratedList). This functionality is expected to be used rarely and sparingly.

Figure 73 – UML class diagram – ExtensionEnumeration sub-model



Live reporting of temporary TROs sub-model

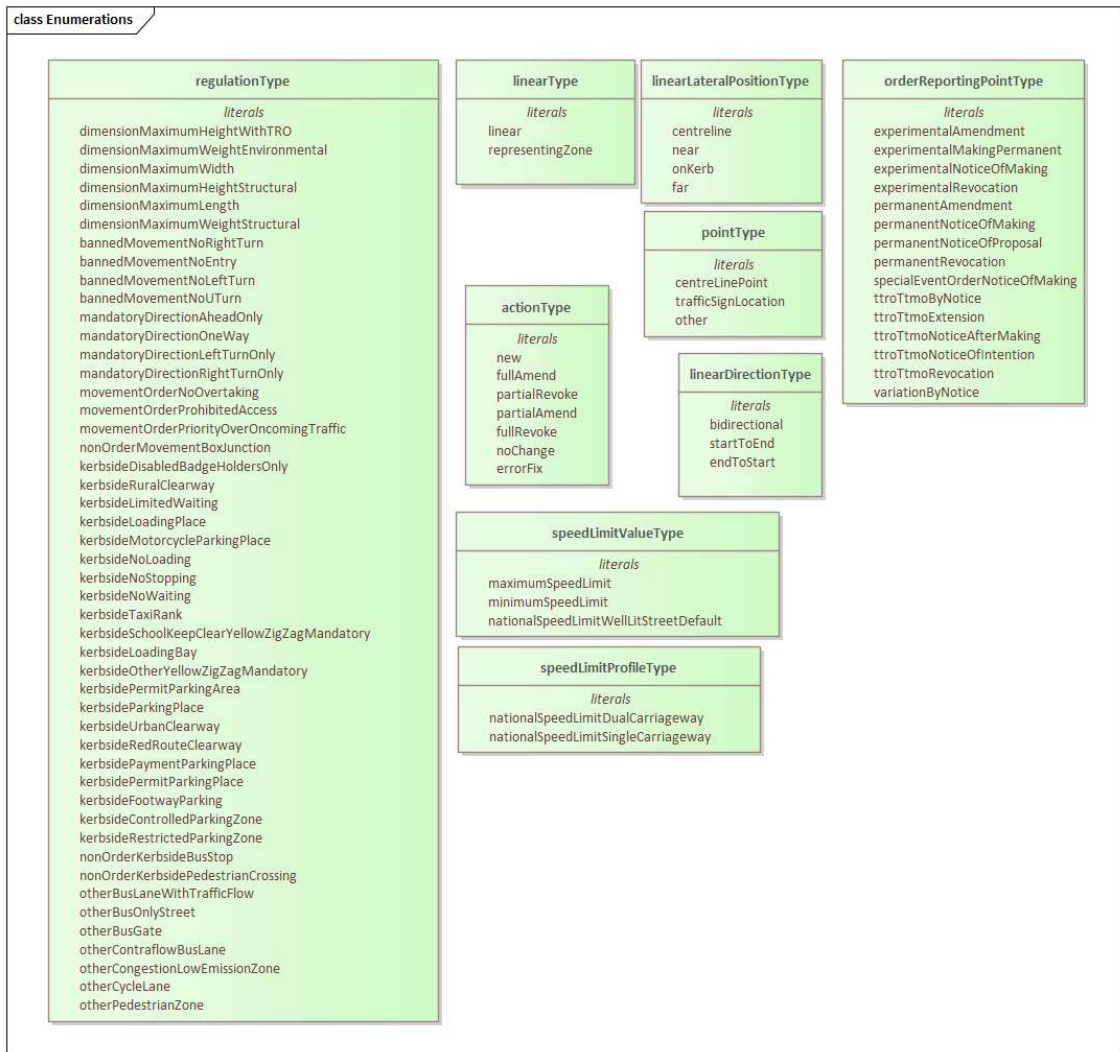
Figure 74 – UML class diagram – TRO On-Road Status Update sub-model



Enumeration classes

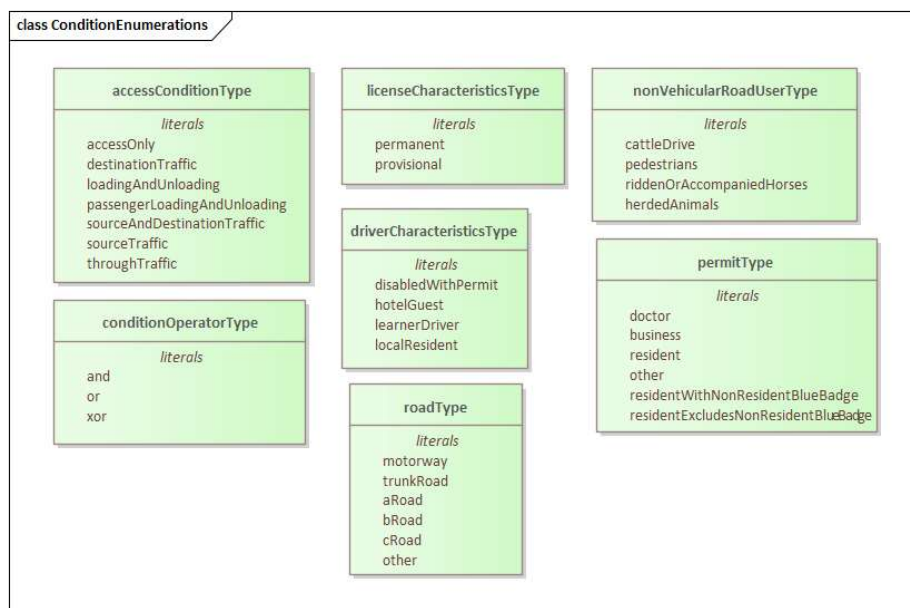
"Regulation" enumerations

Figure 75 – UML class diagram – Enumeration Class in the High-level Regulation sub-model



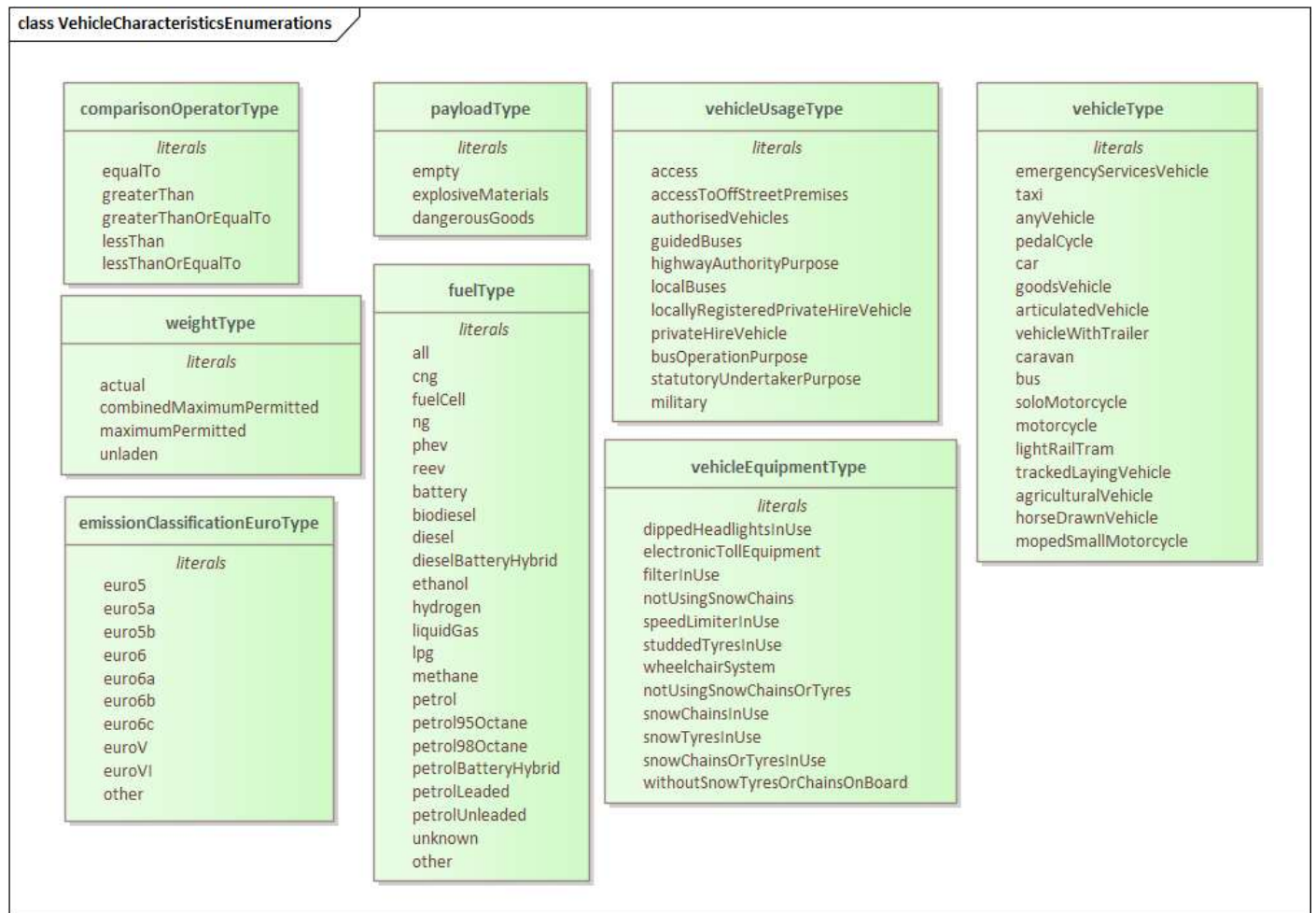
"Condition" enumerations

Figure 76 – UML class diagram – Enumeration Classes in the Condition sub-model



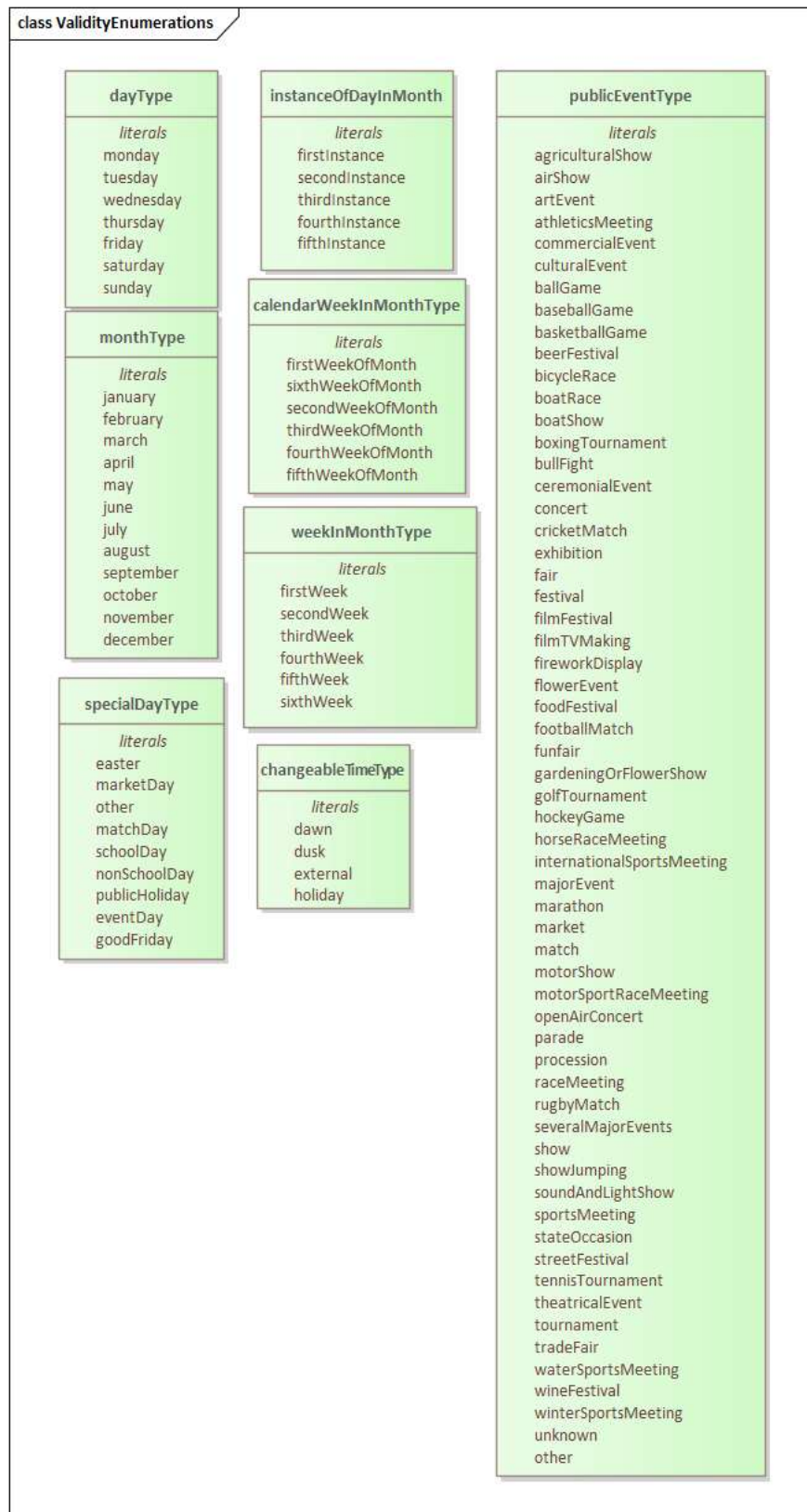
"VehicleCharacteristics" enumerations

Figure 77 – UML class diagram – Enumeration Classes in the VehicleCharacteristics sub-model



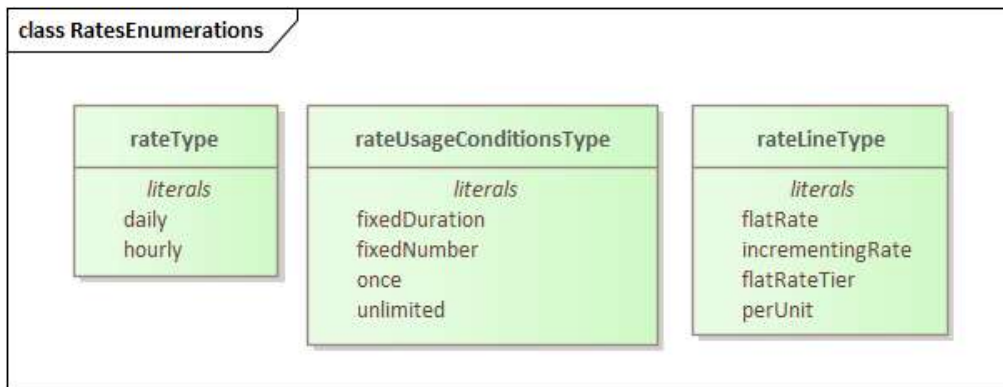
"Validity" enumerations

Figure 78 – UML class diagram – Enumeration Classes in the Validity sub-model



"Rate" enumerations

Figure 79 – UML class diagram – Enumeration Classes in the Rate sub-model



6. Change log

The following critical changes have been made between release 3.1.1 and 3.2.0

1. Inclusion of a Records Management provision
2. Ability to provide Reporting of the real-world status of on road occupancy of TROs (specifically included for TTROs/TTMOs)
3. Development of Location Referencing
4. Proposed approach for Standardised Terms and Definitions

The following change have been made between release 3.2.0 and 3.2.1

- The datatype of the attribute Source.traAffected has been changed from String to an array of integers (int).
- This is the only change.

7. Document Control

Version	Author	Summary of changes	Date
1.0.0	Jonathan Harrod Booth (Harrod Booth Consulting) and PA Consulting	First draft produced for DfT review and comment.	04/07/2024

