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OpenDRIVE® Style Guide, Rev. C

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1 Introduction

Since the first publication of the *OpenDRIVE*® initiative in 2006 many users worldwide started to create databases according to this standard. From version to version additional elements were introduced and increased the options and use cases for each user.

However, *OpenDRIVE*®'s primary goal, in addition to being an open standard, is to maintain the ability of interchanging databases among different creators and users. To achieve this objective, down to the lowest level where various modules and components need to interpret the available data, this document shall provide further details about how to design certain constructs, that could otherwise be realized in ambiguous, potentially nontransferable, ways.

This style guide shall only serve as an appendix to the official "*OpenDRIVE*® Format Specification" and does not invalidate any of the declarations stated there.

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2 Types of Logical Elements

2.1 General

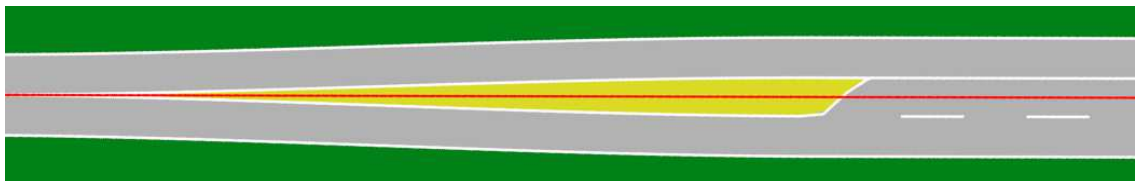
- Any OpenDRIVE® network has to validate the XML-schema corresponding to its version. However, most test the schema can provide are only of syntactic and hierarchic nature.
- The OpenDRIVE® file has to be logically accurate furthermore in case of linking, signaling, unique key - foreign key references, etc., beyond what can be verified by the schema itself.
- One should keep in mind, that user data elements are by definition not portable, but common user data elements could be an idea for a future extension of the standard.

2.2 Roads

All roads of the network have to be built according to the following requirements:

- Roads should generally be built according to common road construction regulations. This includes considerations of regulations for allowed road curvatures and the construction of a continuous trajectory composed of straights, clothoids, arcs and polynomials of third order.

This implies creating the reference line continuously, even if lanes are added, removed or width changes, by using the lane offset feature. An example is shown in the picture below with the reference line marked in red above the gray lanes. The yellow area depicts a restricted traffic area.



reference line on a track using lane offset to model a lane transition

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- Road types and lane types shall be set correctly for the network to enable distinct interpretation of road categories for simulated traffic.

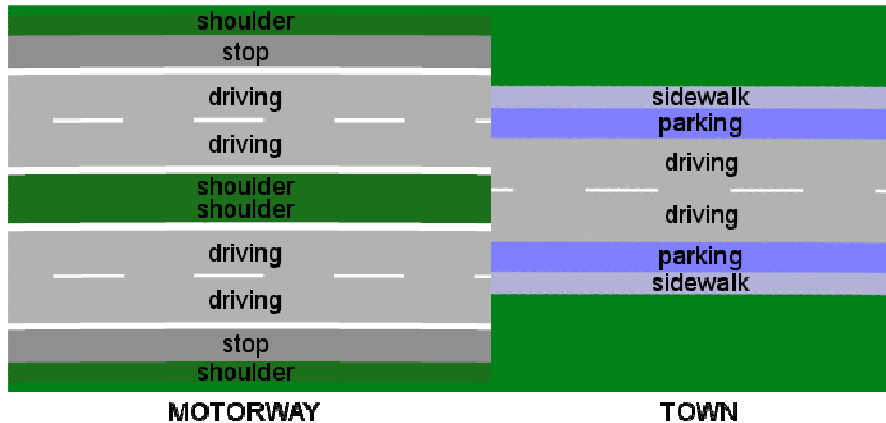


Figure: the picture on the left shows a road of type motorway with different appropriate lanes; the picture on the right a road of type town including parking and sidewalk lanes

- Links between roads and lanes of roads must be correct also with respect to the orientation of the involved elements.
- Lanes that can be used by traffic as drivable or parking lanes of one-way roads must have only IDs corresponding to the intended driving direction:
 - negative IDs for right hand traffic in track orientation and left hand traffic opposite to track orientation
 - positive IDs for right hand traffic opposite to track orientation and left hand traffic in track orientation
- Lanes with zero width shall be avoided over long distances (exception: lane zero).
- The length of roads is only limited by double precision floating-point representation. However, the length should not become too small, because of handling / editing, visualization and optimization algorithms. Typically a length not less than 1 meter may be valid.

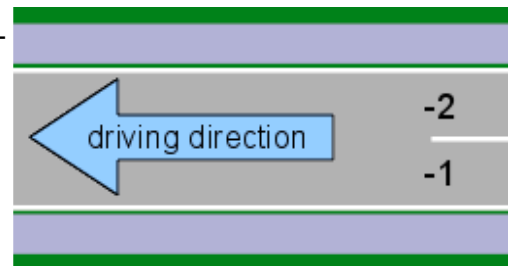


Figure: example for one way road with right hand traffic in track orientation, lanes at the border are of type sidewalk

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2.3 Junctions

- Junctions are necessary at any place where an ambiguity of connections would arise. This means also that no roads may overlap on the same level (i.e. not mentioning bridges etc.) outside the logical construction of a junction.
- All paths describing the possible connections from one given incoming road of a junction have to start exactly at the intended connecting position, irrespective of their target position. The same applies for the ending position of all paths which link to the identical outgoing road. This means in particular: paths must not overlap with incoming and outgoing roads as well as there must not be a gap in between.

Paths may as well have an offset to their connections along the t-axis of the reference line at minimum and maximum s-position respectively.

- All intended possible connections between roads must be defined via connecting paths; a missing connection means that there is no connection available. On the other hand an existing connection does not define that a particular vehicle type may use it (e.g. turning possibility for taxis only).
- Connecting paths:
 - Each connecting path may only consist of one single road, which itself can be composed of multiple lane sections and multiple lanes.

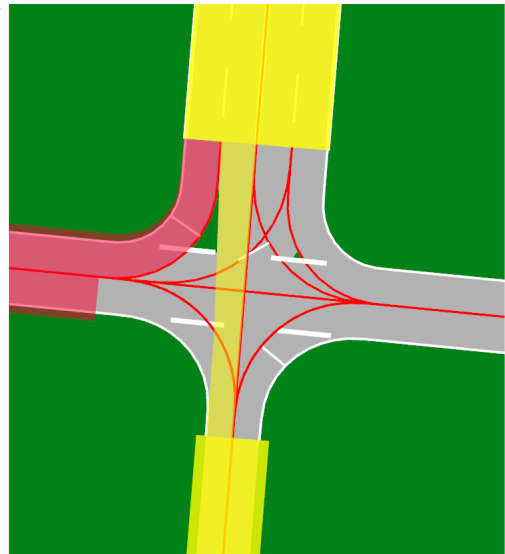


Figure: two paths of a junction: the reference line of the yellow path starts at the position of the incoming road, the red path's reference line has an offset to the incoming reference line along the t-axis

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It is recommended to use one road per path with multiple lanes if necessary.

- The orientation of connecting paths is arbitrary; paths of different orientation can be mixed within one junction.
- It is allowed to use a connecting path with positive and negative lanes for both possible directions of a connection.
- Paths of the same priority, which are meant to be passed simultaneously by different vehicles, must not overlap at all. Exceptions may apply for some vehicle types whose turning circle is too big to follow the trajectory closely. The procedure of leaving the lane and using it as mere guide has to be handled on the application side.
- Overlapping of paths implies solving a right of way situation
- Gaps (areas logically not covered) in junctions shall be avoided. They can be closed with additional lanes of e.g. a straight-through road. Their type shall be *none*.

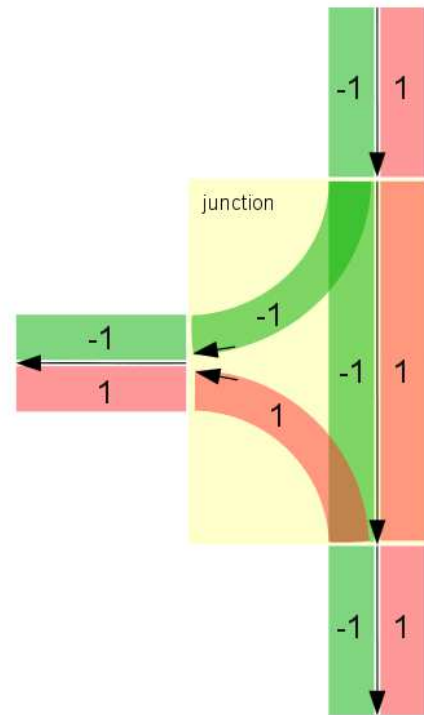


Figure: example of a junction having the following connections: a through road with both directions, a right turning lane in track direction (from top to left) and a right turning lane against track direction (from left to bottom)

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- Traffic signs at junctions:
 - Can be placed graphically and logically before the junction or – for bigger junctions – directly on the connecting paths.
 - If signals, standing outside junctions, do not count for all lanes, lane validity elements have to be defined.
 - Signals, that are placed on connecting paths, have to be referenced from all referring paths. The signal references shall be placed at the position that best matches the original signal position, because this is the position where the sign has an effect on logics.

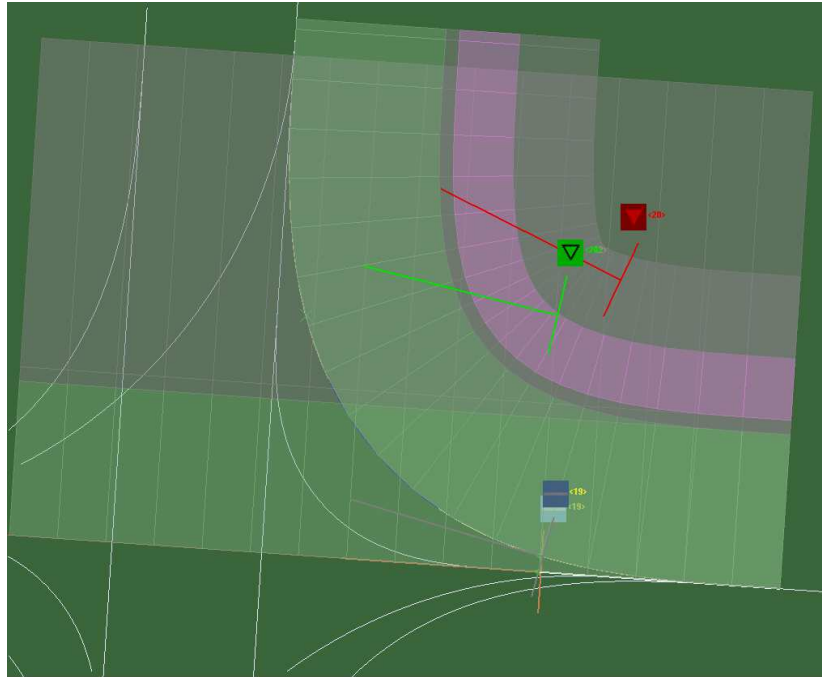


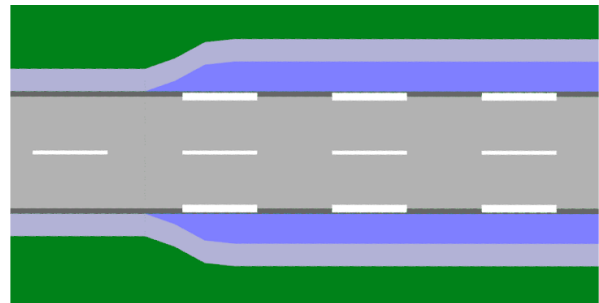
Figure: junction with give way signal (id 20): the green signal is the original one defined on the straight through road, the red one is a reference to the original signal defined on the right turning lane. Only the original signal is graphically visible, references, in contrast, are solely visible to logics.

- Stopping lines and waiting lines are not mandatory for a junction, but when placed they must be at correct (safe) waiting positions.
- Traffic lights shall preferably be assigned to the correct controllers.

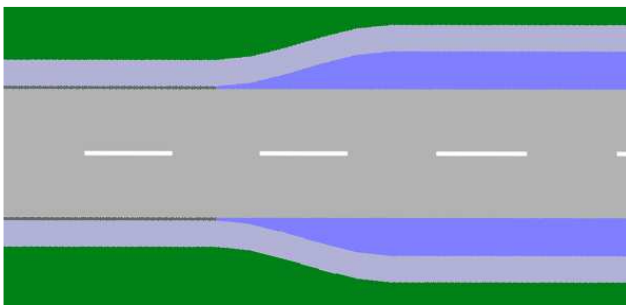
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2.4 Parking Lanes

- Defined as lanes alongside driving lanes with lane type *parking*.
- Can be separated from driving lanes with any kind of road mark like broken, solid or no road mark at all.



parking lanes separated by border (dark grey) and bold broken road marks



parking lanes without road mark or border

- Are allowed to be separated from a driving lane by no more than one border lane.

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2.5 Access and Exit Roads

- Connections between roads and other roads, joining or leaving them, have to be realized by junctions. The length of the connecting paths inside the junctions can be kept short, considering the minimum reasonable length. The position of the junction shall be at the location where the driving lanes of incoming and reuniting roads actually meet or separate. These circumstances are illustrated in the following picture, the junction is drawn dotted.

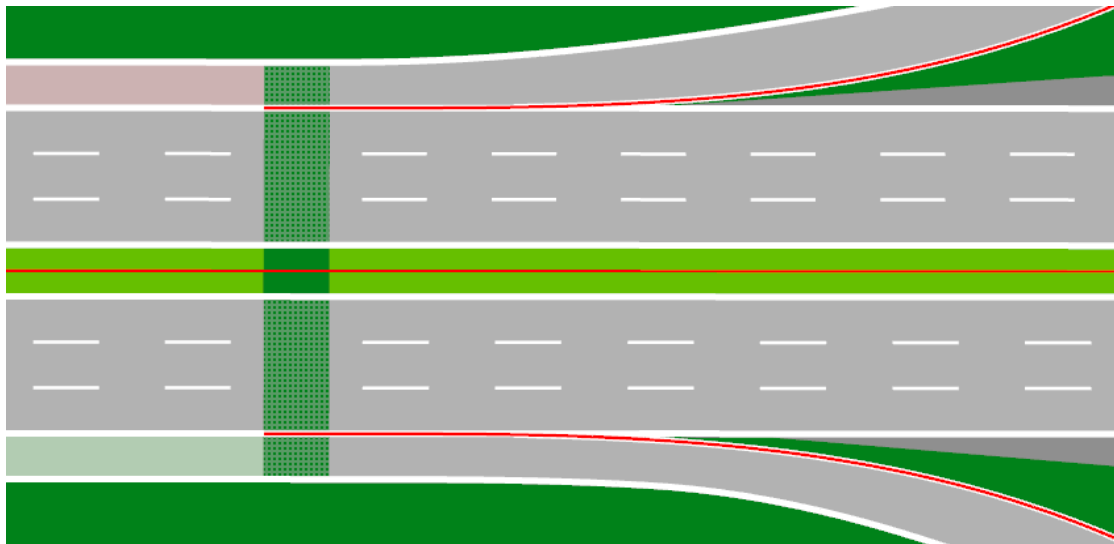


Figure: junction with short (5m) paths modeling the ambiguity at a motorway entry (top) and exit (bottom). The junction is located at the end / begin of the access and exit roads, the acceleration and deceleration lanes belong to the regular motorway track.

- If entry and exit have an offset from each other, two junctions have to be used to model each entry / exit pair. The scheme in the second picture shows how to build such a situation, where both entry and exit roads start at different positions.



Figure: scheme of an entry / exit situation. The yellow rectangles represent simple junctions that connect the incoming and outgoing roads. Each gray line represents a separate road, the leftmost and rightmost roads contain lanes of both driving directions.

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2.6 Signaling

Signals in OpenDRIVE® represent both static and dynamic road signs, traffic lights and special road marks like pedestrian crossings or walkways.

All signals should generally be placed as defined in common road construction regulations. More detailed information would go beyond the scope of this style guide, nevertheless the following rule of thumb may apply: If there are no signals in reality or in the visible database, no signals have to be placed in logics. Real signals, that shall effect a simulation, need a representation in the logical road network.

- It is allowed to omit signals from the logical description that do not have any influence on simulated traffic like some information (“repair service”) or direction (“direction sign to local destinations”) road signs.
- The placement of signs for a simulation may differ from reality to handle limited readability because of the smaller field of view mainly vertically.
- Signals can only be interpreted correctly, if the *type* number is valid according to the country code of the network.
- If the traffic sign catalog of a country does not define unique *type* ids, the OpenDRIVE® type definition has to be used. For the moment this type ID is identical to the German government's rules (see "Strassenverkehrsordnung" or, e.g. http://commons.wikimedia.org/wiki/Category:SVG_road_signs_in_Germany?uselang=de)
- If the traffic sign catalog defines also *subtype* numbers, these shall also be written to the signal definition.
- For the following types of signals the *value* attribute currently has a meaning and should be defined:
 - speed regulation sign (ODR: 274): speed in *m/s*
 - pedestrian crossing (ODR: 293): width in *m*, symmetrical
 - pedestrian walkway (ODR: 1000003): width in *m*, symmetrical
 - additional road signs that define a time span can use the following scheme:
begin time, 2 digits 24-hour clock (BB),
end time, 2 digits 24-hour clock (EE)
=> hour combined to a 4 digit number: BBEE
e.g. 22 to 6 o'clock would be coded into number “2206”.

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