Chair of Geoinformatics
Department of Aerospace and Geodesy
Technical University of Munich

# CityGML 3.0

## Examples for modelling object parts shared by multiple features

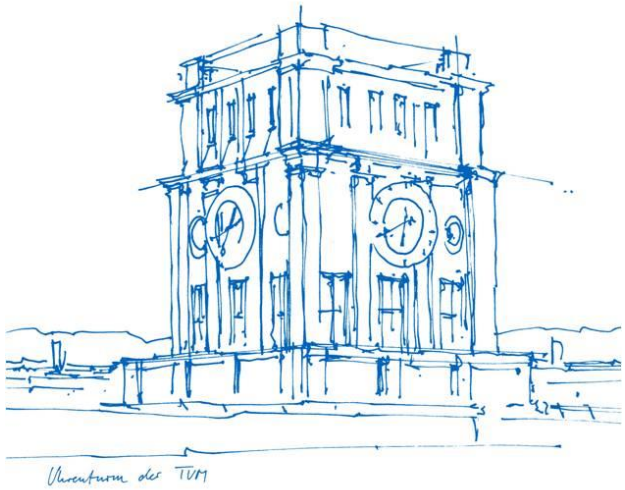
(using CityObjectRelations or XLinks)

**Shared surfaces by**

(1) Roads and Bridges

(2) Buildings and Roads

(3) two Roads (Intersection)



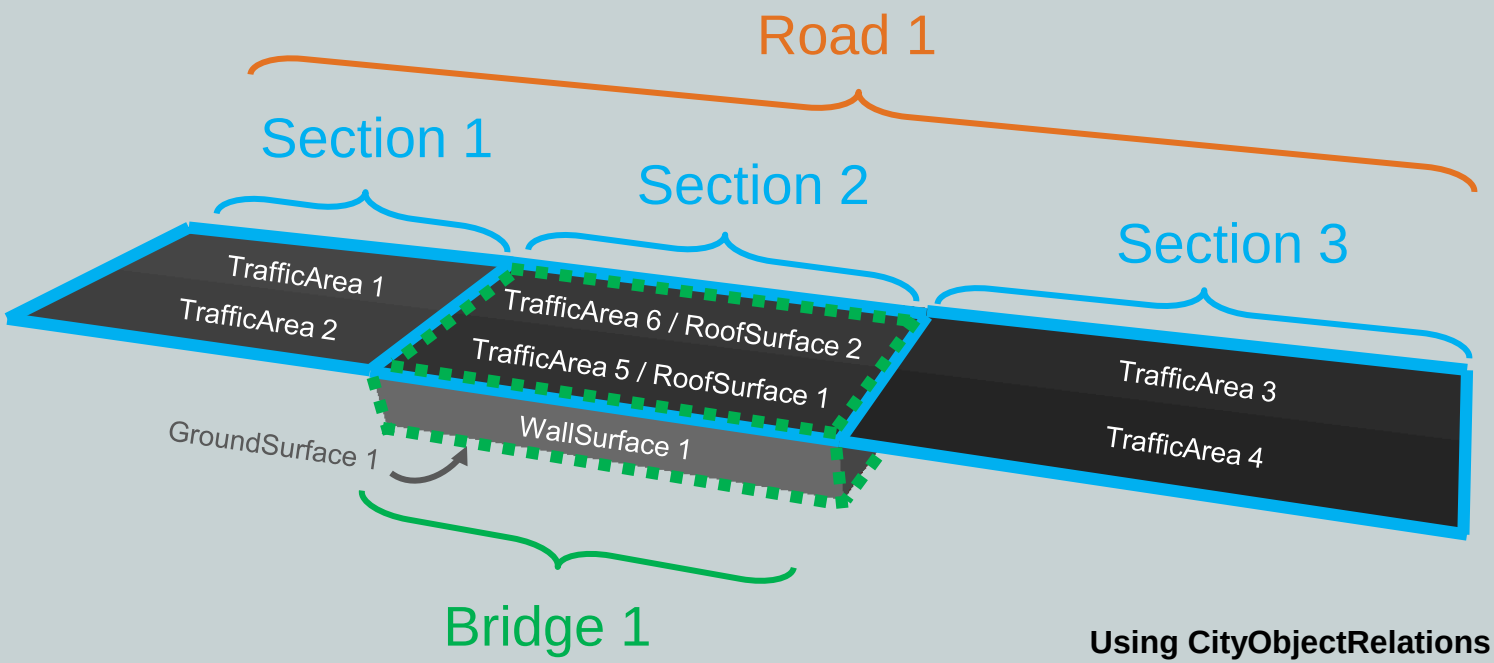
# CityGML 3.0 – Modelling shared object parts

- **Geometrically identical** surfaces can be part of **semantically different** objects.
- E.g. **Road** surfaces on a **Bridge** could be modelled as **TrafficAreas** (as part of a Road) and **RoofSurfaces** (as part of a Bridge) at the same time.
- Transportation networks and **Roads** can reach into **Buildings** (e.g. within a parking garage). In this case **TrafficAreas** are also **Floor-** or **RoofSurfaces**.
- **Intersections** can be part of **multiple Roads**.
- The following examples illustrate how this could be modelled using **CityObjectRelations or XLinks**, with a proposal for when to use which concept.

# Different concepts for modelling shared parts

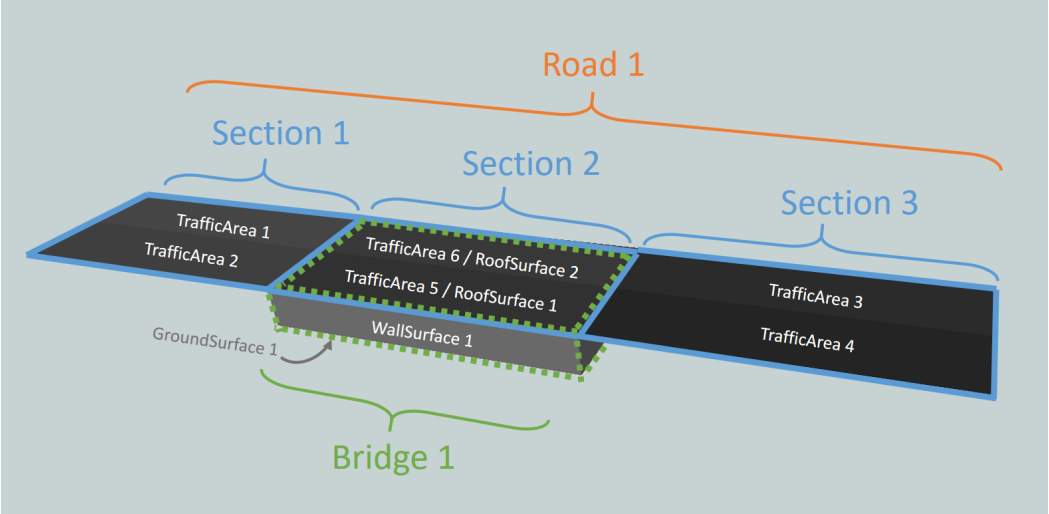
- Shared geometry: XLinks between geometries
  - Disadvantage: In large files, linked geometries may be stored very far apart → not feasible
- Shared features: XLinks to features with identical semantics
  - Disadvantage: In large files, linked objects may be stored very far apart
  - Advantage: Semantically and geometrically identical objects do not need to be represented multiple times
- Explicit linking of related features: CityObjectRelations
  - Disadvantage: Geometry of objects / surfaces needs to be represented redundantly
  - Advantage: Geometry of each object is stored directly with the object. Information on identical (geometrically equal) surfaces is available

# Shared surfaces by Roads and Bridges

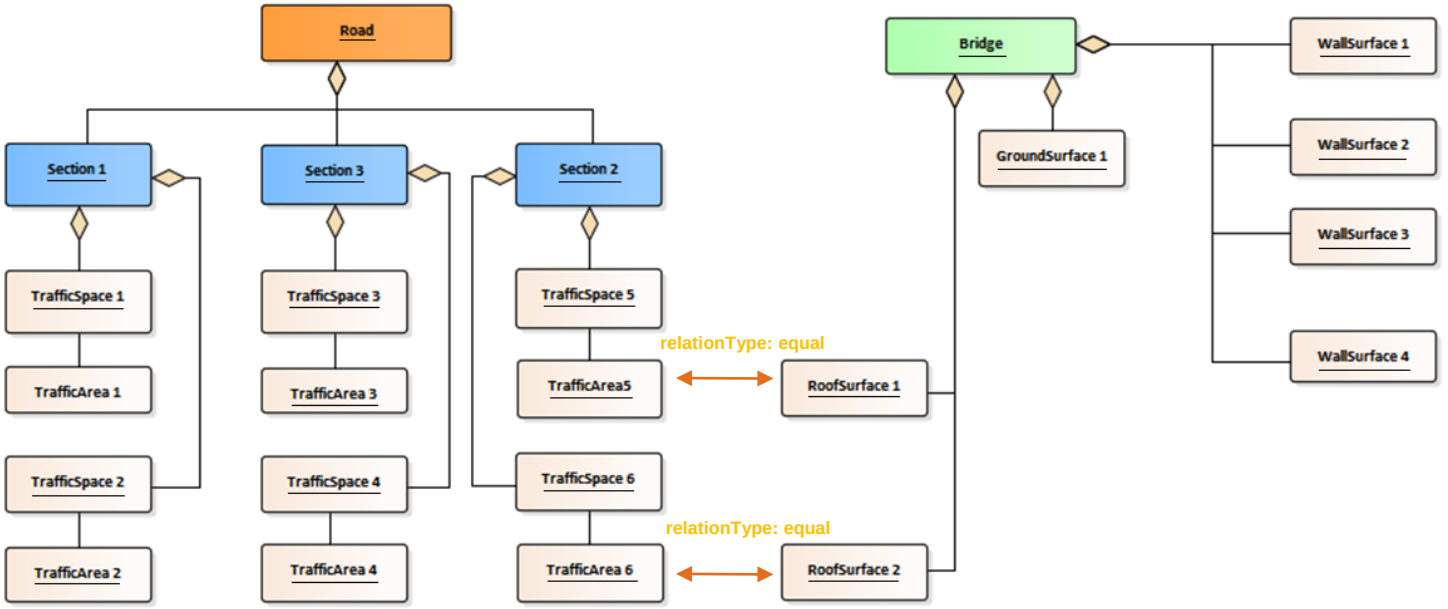



**Using CityObjectRelations makes sense for linking semantically different but geometrically identical surfaces / objects.**

e.g. TrafficArea 5 and RoofSurface 1 represent the same (geometric) surface but are part of different (semantic) objects.




Instance diagram of this example

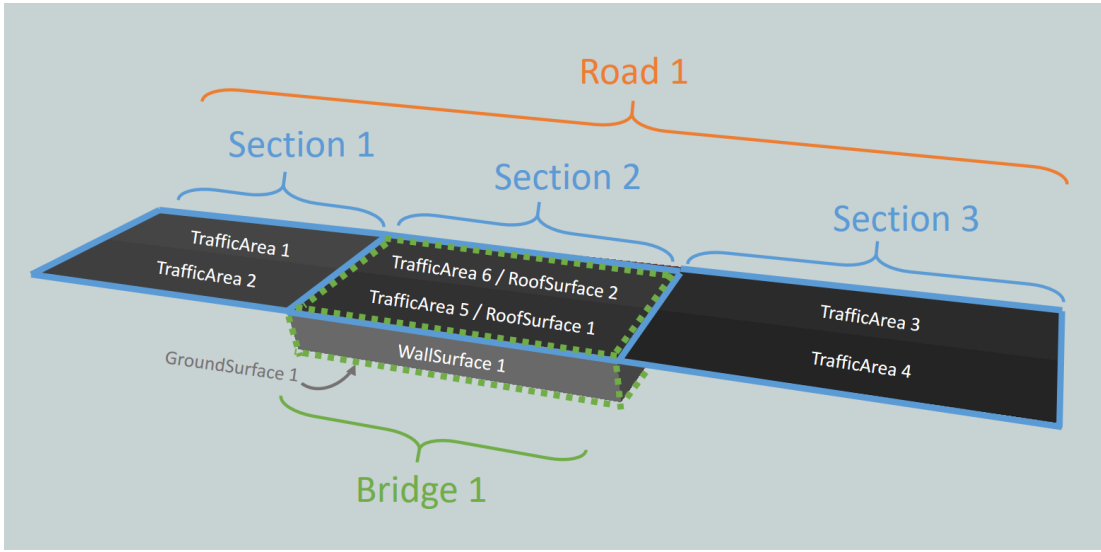


```
<?xml version="1.0" encoding="UTF-8"?>
<core:CityModel xmlns:wtr="http://www.opengis.net/citygml/waterbody/3.0" xmlns
    <core:cityObjectMember>
        <brid:Bridge gml:id="id_bridge1">
            <core:boundary>
                <con:GroundSurface gml:id="id_groundsurface1">
            </core:boundary>
            <core:boundary>
                <con:RoofSurface gml:id="id_roofsurface1">
            </core:boundary>
            <core:boundary>
                <con:RoofSurface gml:id="id_roofsurface2">
            </core:boundary>
            <core:boundary>
                <con:WallSurface gml:id="id_wallsurface4">
            </core:boundary>
            <core:boundary>
                <con:WallSurface gml:id="id_wallsurface1">
            </core:boundary>
            <core:boundary>
                <con:WallSurface gml:id="id_wallsurface2">
            </core:boundary>
            <core:boundary>
                <con:WallSurface gml:id="id_wallsurface3">
            </core:boundary>
        </brid:Bridge>
    </core:cityObjectMember>

    <tran:Road gml:id="id_road1">
        <tran:section>
            <tran:Section gml:id="id_section1">
                <tran:trafficSpace>
                    <tran:TrafficSpace gml:id="id_trafficspace1">
                </tran:trafficSpace>
                <tran:trafficSpace>
                    <tran:TrafficSpace gml:id="id_trafficspace2">
                </tran:trafficSpace>
            </tran:Section>
        </tran:section>
        <tran:section>
            <tran:Section gml:id="id_section2">
                <tran:trafficSpace>
                    <tran:TrafficSpace gml:id="id_trafficspace5">
                </tran:trafficSpace>
                <tran:trafficSpace>
                    <tran:TrafficSpace gml:id="id_trafficspace6">
                </tran:trafficSpace>
            </tran:Section>
        </tran:section>
        <tran:section>
            <tran:Section gml:id="id_section3">
                <tran:trafficSpace>
                    <tran:TrafficSpace gml:id="id_trafficspace3">
                </tran:trafficSpace>
                <tran:trafficSpace>
                    <tran:TrafficSpace gml:id="id_trafficspace4">
                </tran:trafficSpace>
            </tran:Section>
        </tran:section>
    </tran:Road>
</core:CityModel>
```

**Surfaces that represent the exact same area but are semantically different can be connected via CityObjectRelations (= equal)**

relationType: equal

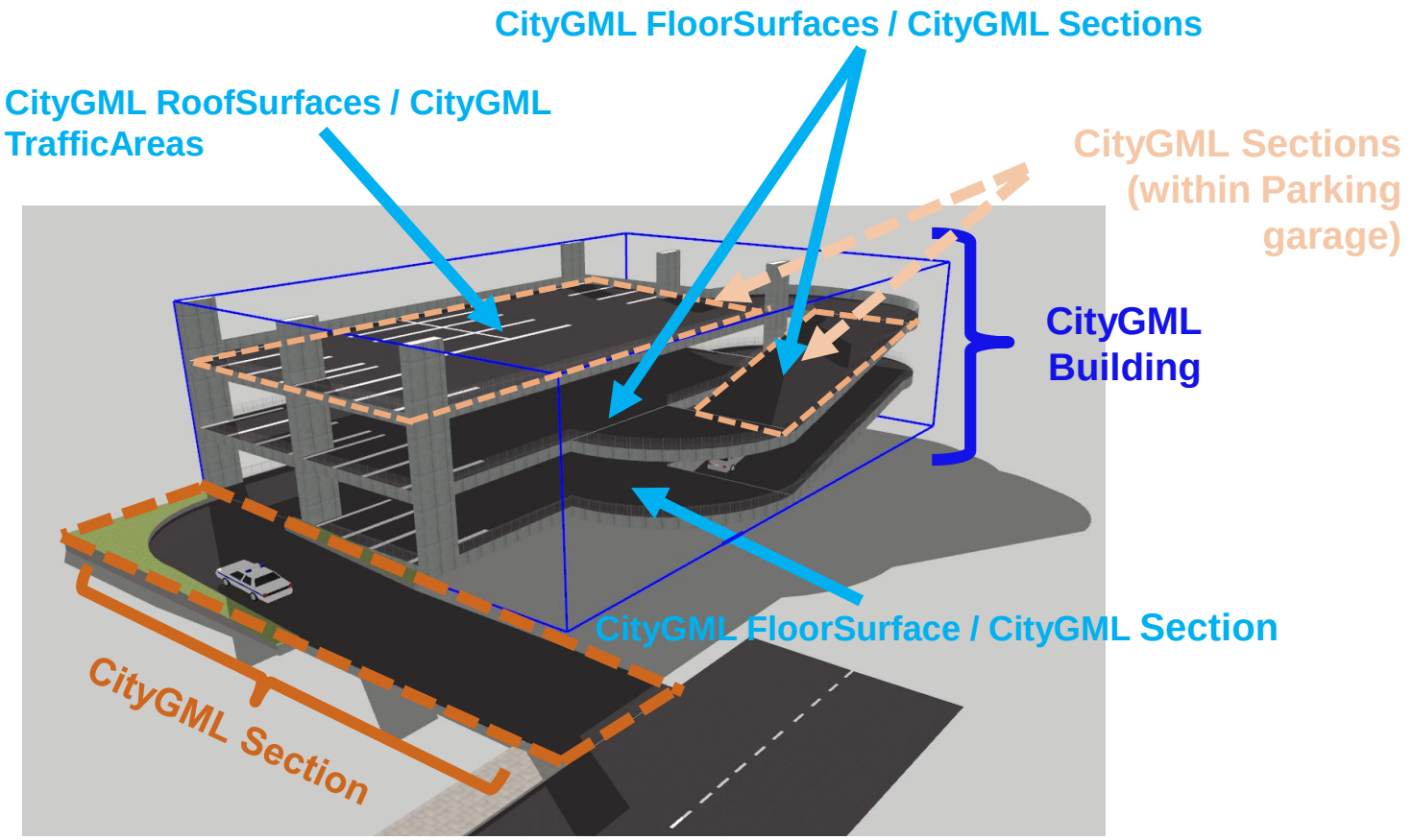


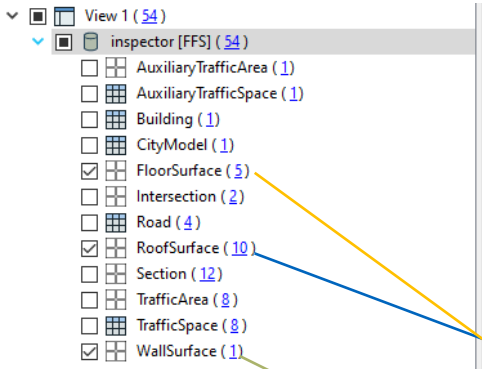
## The CityObjectRelation (= equal) should be available in both directions.

```
<con:RoofSurface gml:id="id_roofsurface2">
    <core:relatedTo>
        <core:CityObjectRelation>
            <core:relationType>equal</core:relationType>
            <core:relatedTo xlink:href="id_trafficarea6"/>
        </core:CityObjectRelation>
    </core:relatedTo>
```

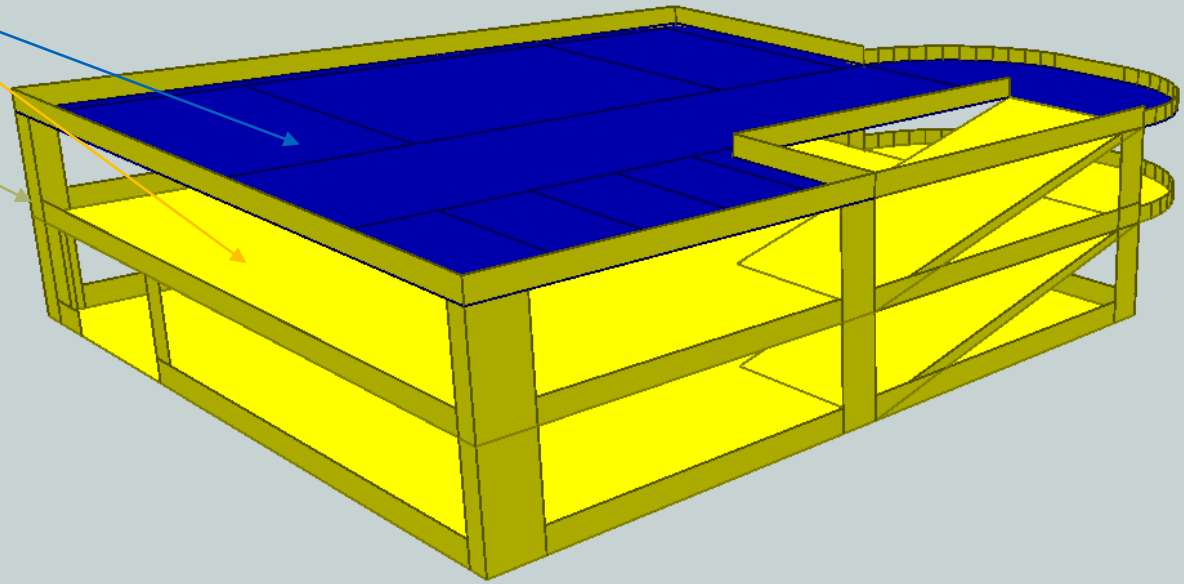
```
<tran:TrafficSpace gml:id="id_trafficspace6">
    <core:boundary>
        <tran:TrafficArea gml:id="id_trafficarea6">
            <core:relatedTo>
                <core:CityObjectRelation>
                    <core:relationType>equal</core:relationType>
                    <core:relatedTo xlink:href="id_roofSurface2"/>
                </core:CityObjectRelation>
            </core:relatedTo>
            <core:lod2MultiSurface>
                <gml:MultiSurface gml:id="id_trafficarea6-0" srsDimension="3">
            </core:lod2MultiSurface>
        </tran:TrafficArea>
    </core:boundary>
    <tran:granularity>lane</tran:granularity>
</tran:TrafficSpace>
```

# Modelling shared surfaces by Buildings and Roads (e.g. within a parking garage) using CityObjectRelations

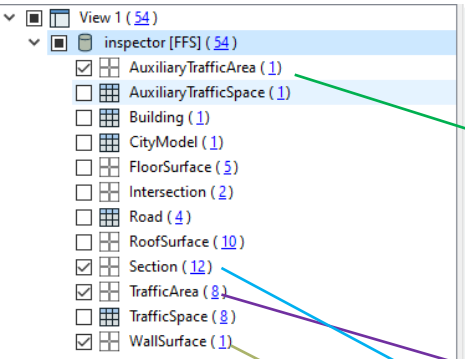





**Parking garage as „classic“ CityGML Building consisting of Floor-, Wall-, and RoofSurfaces.**

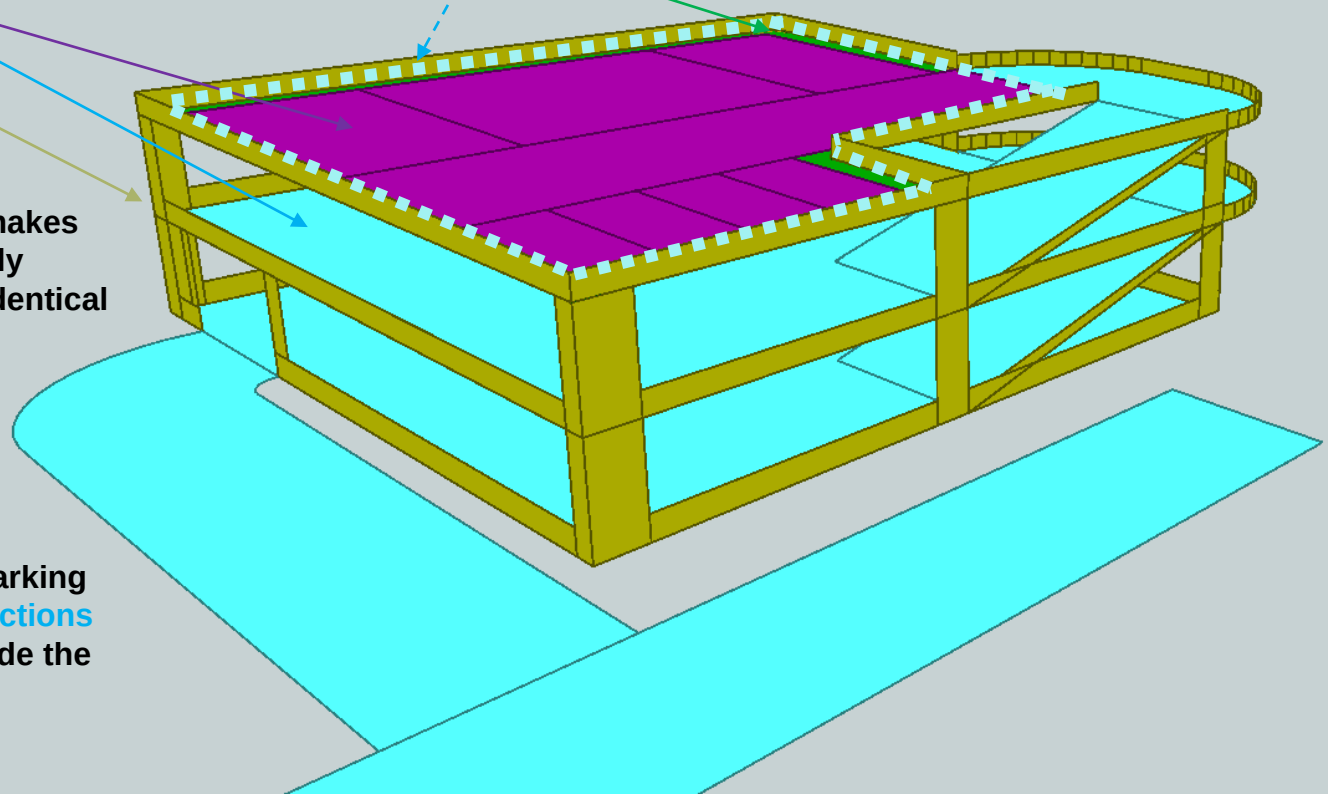


**Each Floor- and RoofSurface is connected to corresponding Sections / (Auxiliary)TrafficAreas via CityObjectRelations (type: equal)**




**At the same time modelled as CityGML Road Object consisting of Sections. (e.g. one Section per level / ramp)**

**The top level of the parking garage in this example is modelled as a Section that is further divided into individual (Auxiliary)TrafficSpaces, bounded by TrafficAreas and AuxiliaryTrafficAreas.**

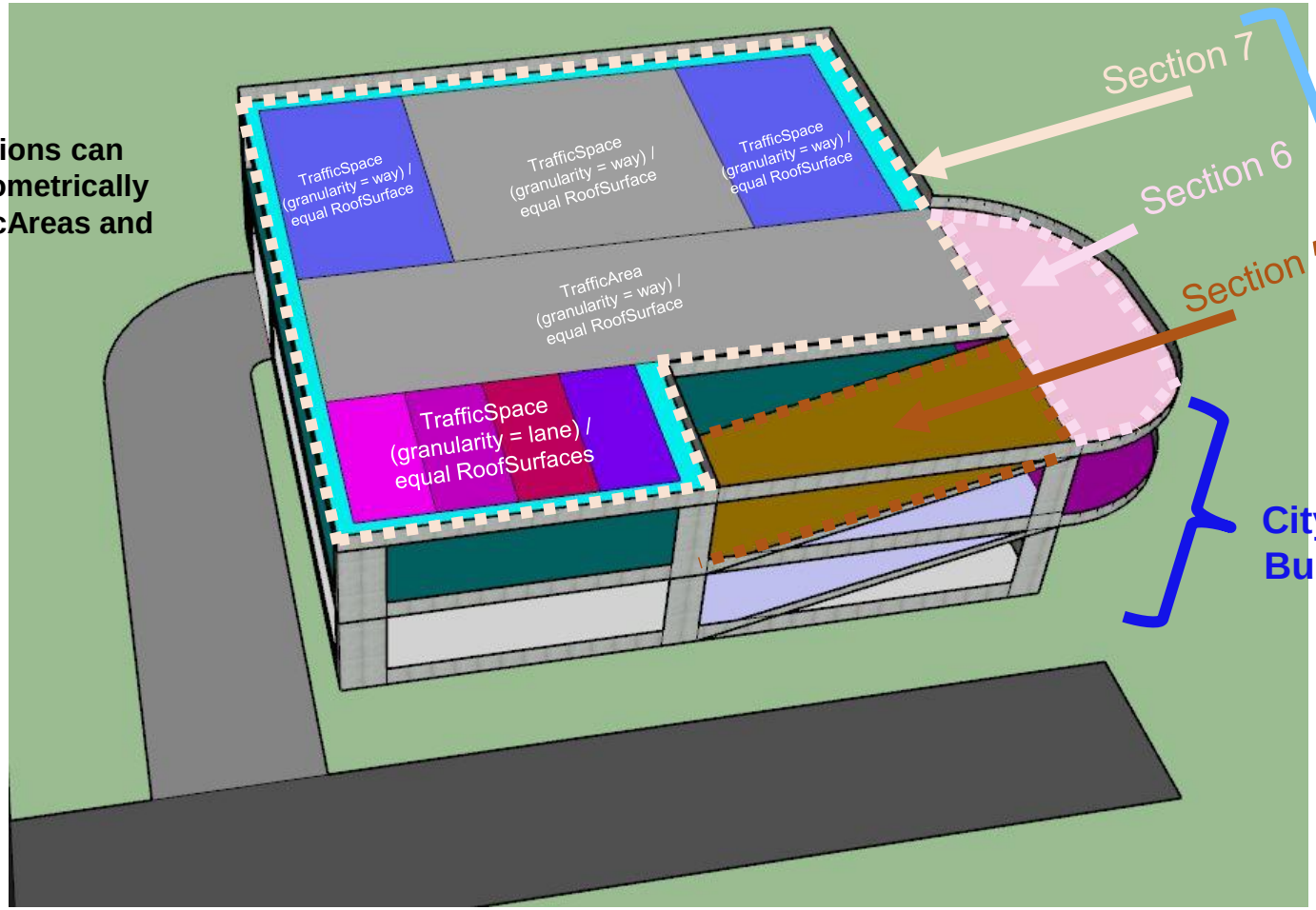


**Using CityObjectRelations makes sense for linking semantically different but geometrically identical surfaces / objects.**

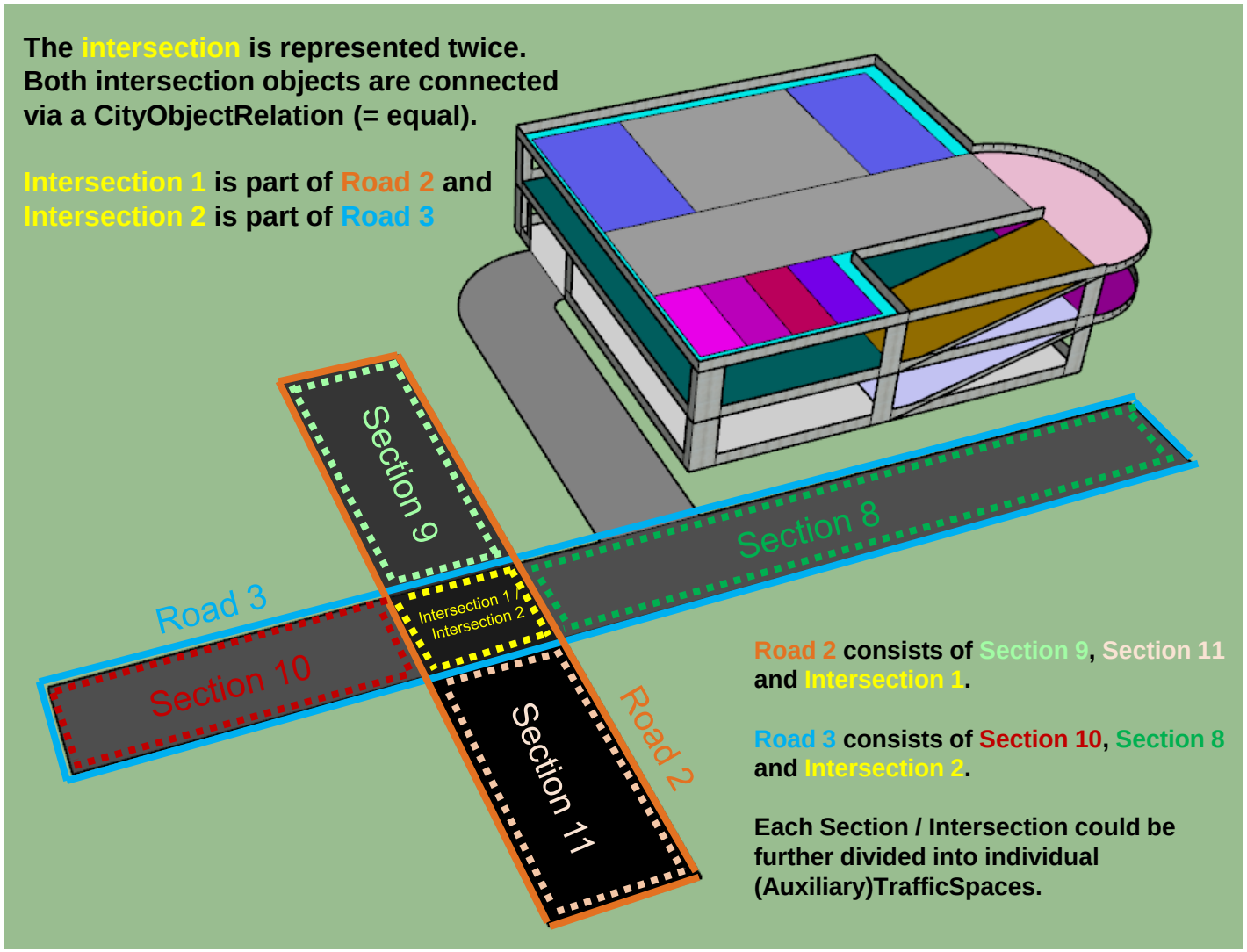
**Road Sections within the parking garage are connected to Sections that are part of Roads outside the parking garage.**

**Entire parking areas are modelled as CityGML TrafficSpaces in granularity „way“ and individual parking lots are modelled as CityGML TrafficSpaces in granularity „lane“. Sections within a parking garage could be part of a separate Road Object.**

**CityObjectRelations can link related (geometrically identical) TrafficAreas and RoofSurfaces.**



# Modelling surfaces of an Intersection that is part of two Roads (Option 1) using CityObjectRelations

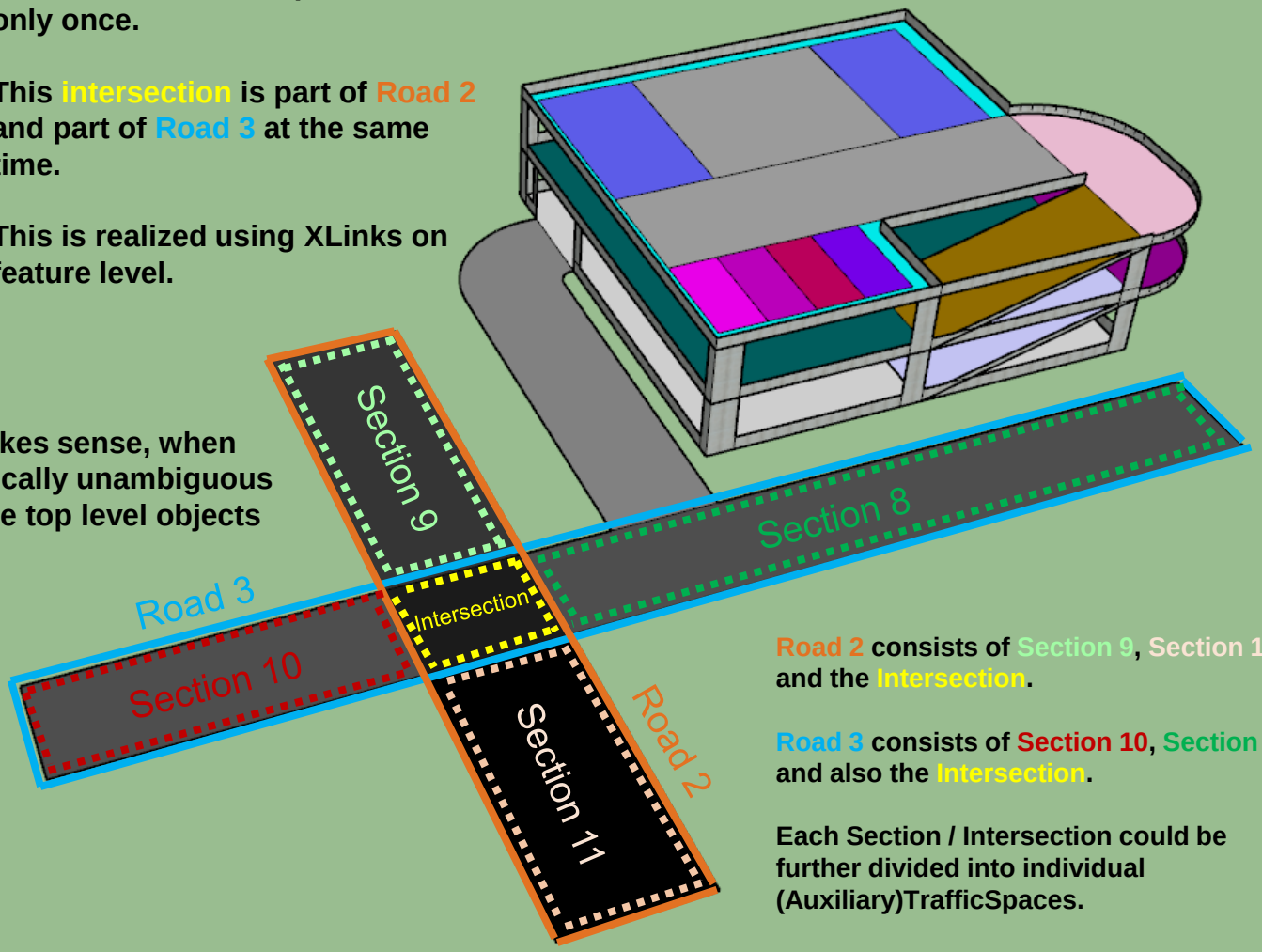


# Modelling surfaces of an Intersection part of two Roads (Option 2) using XLinks

The intersection is represented only once.

This intersection is part of Road 2 and part of Road 3 at the same time.

This is realized using XLinks on feature level.




Using XLinks makes sense, when linking a semantically unambiguous feature to multiple top level objects of the same type.

Road 2 consists of Section 9, Section 11 and the Intersection.

Road 3 consists of Section 10, Section 8 and also the Intersection.

Each Section / Intersection could be further divided into individual (Auxiliary)TrafficSpaces.