# Intro

In the current IFC specification 4x3 RC2and the official ISO standard IFC4 TC1, a concept for geo referencing on a projected coordinate system is available. It allows to specify a conversion to map coordinates of a particular IfcGeometricRepresentationContext with all IfcShapeRepresentation occurrences referencing it. This concept has been put through

evaluation by the infrastructure IFC extension projects and has been deemed insufficient to cover the requirements of data exchange in infrastructure use cases.

# State of the Art and problem statement

The entities for projected CRS geo referencing are encapsulated in the *Project Global Positioning* concept template depicted below.



In a nutshell, any IfcGeometricRepresentationContext has an optional inverse attribute HasCoordinateOperation pointing to an IfcMapConversion. This implies that a coordinate operation has to be performed to convert coordinates to the projected CRS (map coordinates). While the case for coordinate operations is covered by this template a requirement remains for the case where no coordinate operation is supposed to be performed on coordinates. Another issue to consider is referencing geographic coordinate systems as there is only a projected coordinate system availabe.

# **Proposals for solution**

The IFC Tunnel requirements analysis report addresses the above mentioned issue with a simply IsDistorted flag applied to an appropriate entity. Despite the impression that the solution is a minor interference, it is actually a schema change and requires the entire chain of concepts to be adjusted.

This approach seems to be in-line with the discussion in Alignment technical weekly meetings where a distinction between a mere translation of the project base point compared to a translation and transformation of coordinates into a projected coordinate system was discussed. Building on the *Project Global Positioning* concept template where each

IfcGeometricRepresentationContext and its coordinate operation there has to be a clear

and semantically appropriate identifier to convey the information whether only a translation or a translation and transformation of coordinates into the projected coordinate system is to be applied. In order to achieve this, three options are available:

- a renaming of the flag or identifier of the operation (*ProjectionOperation*)

- instead of one identifier, the addition of two (Translation, Projection)

- an enumeration to cover the three specific cases that can occur (TRANSLATION, TRANSLATION\_PROJECTION, PROJECTION)

Entity change:

ENTITY IfcMapConversion

```
SUBTYPE OF (IfcCoordinateOperation);
Eastings : IfcLengthMeasure;
Northings : IfcLengthMeasure;
OrthogonalHeight : IfcLengthMeasure;
XAxisAbscissa : OPTIONAL IfcReal;
XAxisOrdinate : OPTIONAL IfcReal;
Scale : OPTIONAL IfcReal;
Scale : OPTIONAL IfcReal;
ScaleZ : OPTIONAL IfcReal;
OperationType : IfcCoordinationOperationTypeEnum;
```

#### END\_ENTITY;

TYPE IfcCoordinationOperationTypeEnum = ENUMERATION OF

```
(TRANSLATION,
```

TRANSLATION\_PROJECTION,

PROJECTION);

END\_TYPE;

### **Additional requirements**

In order to cover various contexts inside one IfcProject, a proposal for the amendment of the template *Project Global Positioning* shall be discussed. As there is no limitation on the amount of IfcGeometricRepresentaionContext in one IfcProject scenarios where (prefabricated) product coordinates might be in use for a particular element can be imagined. For such elements, the addition of the aforementioned modifications of IfcMapConverion would allow various contexts and various base coordinate systems to coexist in an IfcProject.

Another requirement that should be discussed is the need for *Product (Local and Linear) Placement* to have direct access to IfcGeometricRepresentationContext.



The current IFC schema allows for IfcProduct to have more than one

IfcShapeRepresentation in IfcProductDefinitionShape. Each of these IfcShapeRepresentations can reside in its own IfcGeometricRepresentationContext. The issue with this is that the placement for all representations has to be the same which is not always desirable. There might be a requirement where an IfcProduct is placed in the context of the building but would also require a placement on the transportation vehicle. In this case, various contexts for various purposes are required.

The final requirement is a direct reference to a geographic coordinate system in case there is no map projection available. In general, this requirement should be covered with just a reference to the translation. There are a couple of alternatives on how to deal with this:

1. option:

- a new type for referencing a geographic coordinate system with the parent type **IfcCoordinateOperation** that would not project but just translate the origin (such a translation could also model map translations),

- a new sub type of IfcCoordinateReferenceSystem IfcGeographicCRS.
- addressing Well Known Text (WKT) with a dedicated datastructure

2. option:

- using the existing **IfcMapConversion** and **IfcProjectedCRS** where the attributes dealing with projection do not have values.

The proposal would not require a modification to **IfcMapConversion** with the predefined type and a more generic approach, also covering geographic coordinate systems, would be possible.

Existing entities:

```
ENTITY IfcCoordinateOperation
ABSTRACT SUPERTYPE OF (ONEOF
  (IfcMapConversion));
   SourceCRS : IfcCoordinateReferenceSystemSelect;
   TargetCRS : IfcCoordinateReferenceSystem;
END_ENTITY;
```

ENTITY IfcMapConversion

```
SUBTYPE OF (IfcCoordinateOperation);
Eastings : IfcLengthMeasure;
Northings : IfcLengthMeasure;
OrthogonalHeight : IfcLengthMeasure;
XAxisAbscissa : OPTIONAL IfcReal;
XAxisOrdinate : OPTIONAL IfcReal;
Scale : OPTIONAL IfcReal;
ScaleY : OPTIONAL IfcReal;
ScaleZ : OPTIONAL IfcReal;
```

END\_ENTITY;

The proposed entities:

A translation operation specifies an offset in the coordinate reference system. The rotation is covered In IfcGeometricRepresentationContext.WorldCoordinateSystem. A projection is covered by IfcMapConversion.

ENTITY IfcTranslationOperation

```
SUBTYPE OF (IfcCoordinateOperation);
Eastings : IfcLengthMeasure; // IfcPlaneAngleMeasure
Northings : IfcLengthMeasure;
```

```
OrthogonalHeight : OPTIONAL IfcLengthMeasure;
Scale : OPTIONAL IfcReal;
ScaleY : OPTIONAL IfcReal;
```

END\_ENTITY;

Well known text is a standardized (ISO 19182) text based format to describe coordinate reference systems.

ENTITY IfcWellKnownTextCRS

SUBTYPE OF (IfcCoordinateOperation);

WKT : IfcText;

END\_ENTITY;

Geographic CRS typically requires two angles and a height (can be derived) to specify a location on a body such as ellipsoid, geoid etc.

ENTITY IfcGeographicCRS

SUBTYPE OF (IfcCoordinateReferenceSystem);

//Identifier : OPTIONAL IfcIdentifier;

GeodeticDatum : OPTIONAL IfcIdentifier;

Unit : OPTIONAL IfcNamedUnit;

END\_ENTITY;

### Conclusion

The above described issues have to be resolved in IFC4x3 in order to support exchange scenarios in the Infra domain. Tunnel use cases rely on the resolution and addition of proposed types into the EXPRESS schema and General Usage specification i.e. the IFC schema. In order to accommodate the resolution, a dedicated expert panel is proposed. Compliance with OGC should be addressed by appointing a liaison to collaborate and review the alternatives.