GIS (Geospatial) /BIM INTEROPERABILITY

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Parts

1. **Mapping between GIS (General Feature Model) and IFC metamodel**, both directions

2. **Linking between GIS and BIM.** The relationship between feature types in GIS and logical coupling of elements in IFC.

3. **Transformation between GIS and BIM coordinates.** GIS has a scale factor in their projections, which may give deviations when it comes to high precision data). Focus on user requirements and solutions.
Start-up comments

• Used term: GIS (geomatics) / BIM interoperability

Narrower view:

• GIS (geomatics):
  – The ISO/TC211-way of structuring geospatial information
  – Using UML and information exchange using GML

• BIM
  – The ISO/TC59 SG13-way, using IFC / IFD / IDM
(3b) Mapping between GIS (General Feature Model) and IFC metamodel, both directions

Content
• ISO19109 General Feature Model (GFM)
• IFC Metamodel (?)
• Comparison
• Mapping challenges
Content

• NS-EN ISO 19109:2015 General Feature Model
• ISO 16739:2013, IFC Conceptual Model IFC4 add 2

• Comparing on different level
  – ISO19109 Rules for Application Schemas
  – ISO 16739 «The IFC Application Schema»
Modelling differences

- **ISO/TC211**:  
  - Standardised in ISO19109: Rules for application schema  
  - Users define their own application schemas using these rules  

- **IFC**:  
  - Standardised IFC Application Schema  
  - Hard to extract IFC Metamodel (?)  
  - Challenges to add users defined extensions to IFC  
    - Possible (but hardly used?) in IFD / bSDD
Interoperability goal

• Representation of selected parts from a geospatial dataset in an IFC file
  – Possible use cases: One dataset for all information needed in a building permit application (the building and its neighbourhood)

• Representation of selected parts from an IFC dataset in a geospatial dataset
  – Possible use case: Indoor walkway in shopping centres, hospitals, airports, railway stations, bus stations
Interoperability goals (cont...)

- Full roundtrip?
  - The full content of a geospatial dataset can be represented in an IFC file
  - The full content of an IFC dataset can be represented in a geospatial dataset
- SW handling both GIS and BIM data
  - Standardization needed?
- Probable solutions:
  - Full roundtrip not needed, no use cases (?)
  - One-directional, partial solutions will be needed
General Feature Model (GFM)
GFM
Attribute types

Figure 7 — Attributes of feature types
Application Schema Integration

Figure 9 — Example of application schema integration
IFC
IFC Data Schema Architecture

Source:
http://www.buildingsmart-tech.org/mvd/IFC4Add1/RV/1.0/html/
Identified challenges

- Terminology
- Modelling languages: UML vs EXPRESS
- Associations
- Objects and properties
- Objects and TypeObjects

For part 3d (later today):
- Spatial Structure Elements
- Classifications
- Use of the «new» GIS FeatureTypes in IFC4

For part 4 (later today)
- Location / Global reference systems
**Terminology**

**GFM/UML**
- Feature types
- Datatypes
- Codelists

**UML Classes**
  - Stereotypes
  - Attributes
  - Associations

**IFC/Express**
- Root/Object definition/Object/ Product/Element

**EXPRESS**
  - Types («basic types», codelists/typedefs)
  - Entities
    - Attributes
  - Property sets
  - Quantity sets

NB! UML/Class Attribute = EXPRESS/Entity Attribute
IFC Root

- EXPRESS G
- UML Class
EXPRESS example

ENTITY IfcElement
SUBTYPE OF (IfcProduct);
  Tag : OPTIONAL IfcIdentifier;
INVERSE
  Fillsvoids : SET [0:1] OF IfcRelFillsElement FOR RelatedBuildingElement;
  ConnectedTo : SET [0:?] OF IfcRelConnectsElements FOR RelatingElement;
  IsInterferedByElements : SET [0:?] OF IfcRelInterferesElements FOR RelatedElement;
  InterferesElements : SET [0:?] OF IfcRelInterferesElements FOR RelatingElement;
  HasProjections : SET [0:?] OF IfcRelProjectsElement FOR RelatingElement;
  ReferencedInStructures : SET [0:?] OF IfcRelReferencedInSpatialStructure FOR RelatedElements;
HasOpenings
  IsConnectedBy : SET [0:?] OF IfcRelConnectsElements FOR RelatedElement;
  ContainedIn : SET [0:?] OF IfcRelContainsElements FOR RelatingElement;
  HasCoverings : SET [0:?] OF IfcRelCoverings FOR RelatingElement;
END_ENTITY

ENTITY IfcBuildingElement
SUBTYPE OF (IfcElement);
WHERE
  MaxOneMaterialAssociation : SIZEOF (QUERY(temp <> SELF\IfcObjectDefinition.HasAssociations | 'IFCPRODUCTEXTENSION.IfcRelAssociatesMaterial' IN TYPEOF(temp)) <= 1;
END_ENTITY

EXPRESS-G diagram
IFC in UML

My personal incomplete IFC/UML-model
Associations / Relationships

Figure 8 — Relationships between feature types
Features/objects and properties

Class RelDefinesByProperty

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FeatureType</td>
<td>- featureType: CharacterString [0..4]</td>
</tr>
<tr>
<td>PropertyType</td>
<td>- PropertyType: CharacterString [0..4]</td>
</tr>
<tr>
<td>FeatureAssociationType</td>
<td>- FeatureAssociationType: CharacterString [0..4]</td>
</tr>
<tr>
<td>AttributeType</td>
<td>- AttributeType: CharacterString [0..4]</td>
</tr>
</tbody>
</table>

History:
- New entity in IFC2.0. Has been renamed from IfcRelAssignsProperties in IFC2x.
- IFC4 CHANGE: The attribute RelatedObjects had been demoted from the supertype IfcRelDefines to IfcRelDefinesByProperties. This relationship has been modified to support multiple property sets referenced by a single relationship.

Figure 5 — The General Feature Model
4.2.2.1 Property Sets for Objects

The concept template Property Sets for Objects describes how an object occurrence can be related to a single or multiple property sets. A property set contains a single or multiple properties. The data types of an individual property are single value, enumerated value, bounded value, table value, reference value, list value, and combination of property occurrences.

Property sets can also be related to an object type, see concept Property Sets for Types. They then define the common properties for all occurrences of the same type. If the same property (by name) is provided by the same property set (by name), then the properties directly assigned to the object occurrence override the properties assigned to the object type.

### Property Sets for Objects

The Property Sets for Objects concept template applies to this entity as shown in Table 108.

<table>
<thead>
<tr>
<th>PredefinedType</th>
<th>PsetName</th>
<th>Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pset_CoveringCommon</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pset_EnvironmentalImpactIndicators</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pset_EnvironmentalImpactValues</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pset_Condition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pset_ManufacturerOccurrence</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pset_ManufacturerTypeInfo</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pset_ServiceLife</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pset_Warranty</td>
<td></td>
</tr>
</tbody>
</table>

Table 108 — IfcCovering Property Sets for Objects
Objects and TypeObjects

TypeObjects not used in GFM
Differences

• IFC/TypeObjects do not exist in GFM
  – Solution needed if IFC data using this option is to be represented in a geospatial dataset

• Looser connection between features/elements and properties in IFC than in GFM.
  – Solution needed for all interoperability
(3d) Linking between GIS and BIM. The relationship between feature types in GIS and logical coupling of elements in IFC.

- The GIS method: Collection of instances
  - e.g. GML Feature Collection
- The IFC method: Entities with strong relationships to other entities and to groups of entities
Content

• Spatial Structure Elements
• Classifications
• Use of the «new» GIS FeatureTypes in IFC4
• Needed harmonisation
Spatial Structure Elements

Figure 183 — Spatial structure element composition
Spatial Structure Elements
UML-version

Class SpatialStructureElements

- IfcRoot (root)
- IfcObjectDefinition
- IfcContext
- IfcObject
- IfcProduct
- IfcSpatialElement
- IfcSpatialStructureElement
- IfcGroup
- IfcSite
- IfcProject
- IfcBuilding
- IfcBuildingStorey
- IfcSpace
- IfcSpatialZone
- IfcSystem
IFC Group and IfcSystem
On use of IfcSystem

• IfcSystem important for simulations
  – Capacity in distribution systems
  – Structural Analysis models

• Doubtful if there are any GIS Usecases for this?
  – Possible: Indoor transport system e.g. in hospitals and shopping centres
IfcClassification

An IfcClassification is used for the arrangement of objects into a class or category according to a common purpose or their possession of common characteristics. A classification in the sense of IfcClassification is taxonomy, or taxonomic scheme, arranged in a hierarchical structure. A category of objects relates to other categories in a generalization-specialization relationship. Therefore the classification items in an classification are organized in a tree structure.

The IfcClassification identifies the classification system or source to which a classification reference refers to. Each classification reference may reference an instance of IfcClassification. A classification system declared may be either formally published, or it may be a locally defined method of classifying information.

NOTE Examples for such formally published classifications are Omniclass, Uniclass, Masterformat, or DIN277.
Classifications

- **IfcClassification**: A classification is a collection of classes, typically used to group similar objects or concepts.

- **IfcExternalReference**: An external reference that can be linked to documents or libraries.

- **IfcExternalInformation**: Contains information about external documents or libraries.

- **IfcClassificationReference**: A reference to a classification, including a source and a description.

- **IfcRelAssociatesClassification**: Relates a classification to other objects or classes.

- **IfcRoot**: The root node of the classification hierarchy.

- **IfcObjectDefinition**: A definition of an object, including a name and description.

- **IfcPropertyDefinition**: A definition of a property, including a name and description.

- **IfcDocumentInformation**: Information about a document.

- **IfcLibraryInformation**: Information about a library.

- **IfcClassificationReferenceSelect**: A select class for classification references.

- **IfcRelAssociatesSelect**: A select class for relationship associations.

- **IfcClassificationSelect**: A select class for classifications.
IFC4 Elements for «GIS FeatureTypes»?

- **IfcGeographicElement**
  - An IfcGeographicElement is a generalization of all elements within a geographical landscape. It includes occurrences of typical geographical elements, often referred to as features, such as trees or terrain. Common type information behind several occurrences of IfcGeographicElement is provided by the IfcGeographicElementType.

- **IfcCivilElement**
  - An IfcCivilElement is a generalization of all elements within a civil engineering works. It includes in particular all occurrences of typical linear construction works, such as road segments, bridge segments, pavements, etc.
  - Depending on the context of the construction project, included building work,
    - such as buildings or factories, are represented as a collection of IfcBuildingElement's,
    - distribution systems,
    - such as piping or drainage, are represented as a collection of IfcDistributionElement's, and
    - other geographic elements, such as trees, light posts, traffic signs etc. are represented as IfcGeographicElement's.

What about the properties/attributes?
More on IfcGeographicElementType

5.4.3.23 IfcGeographicElementType

- Natural language names
- Change log

5.4.3.23.1 Semantic definitions at the entity

- Entity definition
  An IfcGeographicElementType is used to define an element specification of a geographic element (i.e. the specific product information, that is common to all occurrences of that product type). Geographic element types include for different types of element that may be used to represent information within a geographical landscape external to a building. Within the world of geographic information they are referred to generally as 'features'. IfcGeographicElementType's include:
  - point features such as seating, bus shelters, signage, trees;
  - linear features such as layby's;
  - area features such as ponds, lakes, woods and forests;
  - drainage such as catchment, reservoir or outfall.

  The specification of the specific types are given by the inherited attribute IfcElementType.ElementType given as an IfcLabel.

  Geographic element types are frequently identified in feature catalogs that are produced for particular purposes. The IfcGeographicElementType entity enables the continued use of existing feature catalogs through capture of their identity and attributes.

  Information from feature catalogs might be captured in various ways:
  - via property sets, some of which will be specifically defined within the IFC property set catalog whilst others will be created for local use; this is the form of capture that is expected to be most widely used
  - through use of the IFC classification model whereby features might be identified through an IfcClassificationReference with additional description, in which case, any further attributes required would still need to be captured in property sets.
Connection
IFC/Classification – GFM/Application Schema
Suggested extensions to Spatial Structure Elements

Source: IFC Infra Overall Architecture Project - Documentation and Guidelines (draft version 2017-02-03)
IfcSite: Extent?

Illustration: IFC dataset with neighborhood

Site extent:
- Parcel?
- Neighbours?
- Area influenced by new building?
- Possible with several extents for the same site?
Standardisation challenges

• Dataset cannot be transferred back and forth between IFC and GFM without overcoming severe challenges
  – Probably no use cases with need for this (?)

To be solved:

• Differences in connections between features and properties
• Representation of GFM User Application schemas in IFC
  – Using IFC/Classification seems reasonable, unclear how
(4) Transformation between GIS and BIM coordinates.

GIS has a scale factor in their projections, which may give deviations when it comes to high precision data). Focus on user requirements and solutions

Content:
• Geomatics and the challenge of flattening the earth surface
• IFC and Cartesian coordinate systems
• Challenges and possible solutions
Geomatics challenge

• People relate to the earth surface as a plane surface
  – Zero level defined by «sea level»
• Maps are traditionally printed on flat sheets
• Most mathematics become easier in a Cartesian coordinate system than in other systems describing the earth surface
• How can Cartesian systems be used to describe the earth surface?
Challenge 1: Horizontal

- Keeping control of the errors distortions
  - scale, directions, area
Scale distortion

• UTM (Universal)
  – Acceptable with 400ppm distortion, equals 4cm pr 100m
  – Not acceptable for building and construction

• Local coordinate systems with less distortion
  – Norway: NTM
  – Max 11 ppm, equals 1,1mm pr 100m
  – Cost:
    • not only 3 UTM zones for Norway, but 25 NTM zones
Challenge 2: Vertical

- Geoide
  - "sea level"
  - Influenced by gravitation
- Ellipsoid
  - "satellite height"
  - Used by GNSS

isostatic uplift (mm/year)
ISO 19111:2007
Geographic information – Spatial referencing by coordinates
Datums and coordinate reference systems

4.14
**datum**
parameter or set of parameters that define the position of the origin, the scale, and the orientation of a coordinate system

4.8
**coordinate reference system**
coordinate system that is related to an object by a **datum**

**NOTE** For geodetic and vertical datums, the object will be the Earth.
Cartesian coordinate system

The prototypical example of a coordinate system is the Cartesian coordinate system. In the plane, two perpendicular lines are chosen and the coordinates of a point are taken to be the signed distances to the lines.

In three dimensions, three perpendicular planes are chosen and the three coordinates of a point are the signed distances to each of the planes. This can be generalized to create \( n \) coordinates for any point in \( n \)-dimensional Euclidean space.

Depending on the direction and order of the coordinate axes the system may be a right-hand or a left-hand system. This is one of many coordinate systems.

NOTE \( n \) is 2 or 3 for the purposes of this International Standard.
Registries for Spatial Reference systems:

Commonly used:
- EPSG (www.epsg.org)

Upcoming (?) register:
- ISO/TS 19127 Geographic information – Geodetic codes and parameters
  - based on:
    - ISO 19111 Geographic information – Spatial referencing by coordinates
    - ISO 19135 Geographic information – Procedures for item registration
IFC4 Geolocation

Dark blue ifc2x3 and ifc4
Light blue ifc4 additions
Upright: mandatory attributes
Italics: optional attributes
Full arrow: mandatory relationship
Dotted arrow: optional relationship

Source:
Nich Nisbet AEC3,
Oslo Oct 2017
### Entity Inheritance

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Type</th>
<th>Cardinality</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>instance</td>
<td>?</td>
<td>Name by which the coordinate reference system is identified. Note: The name shall be taken from the list recognized by the European Petroleum Survey Group EPSG. It should then be qualified by the EPSG code space, for example as EPSG:5511.</td>
</tr>
<tr>
<td>Description</td>
<td>instance</td>
<td>?</td>
<td>Internal description of the coordinate reference system.</td>
</tr>
</tbody>
</table>
| GeographicDatum | instance   | ?           | Name by which this datum is identified. This geographic datum is associated with the coordinate reference system and indicates the shape and size of the rotation ellipsoid and this ellipsoid's connection and orientation to the actual globe/earth. It needs to be provided, if the name identifier does not unambiguously define the geographic datum as well. Example: present datums include: 

  - E660
  - ERF19
  - WGS84 |
| VerticalDatum | instance   | ?           | Name by which the vertical datum is identified. The vertical datum is associated with the height axis of the coordinate reference system and indicates the reference plane and fundamental point defining the origin of a height system. It needs to be provided, if the name identifier does not unambiguously define the vertical datum as well and if the coordinate reference system is a 3D reference system. Example: vertical datum include:

  - DEH82: the German ‘HauptOrthoetz’
  - ETRS89: the European Vertical Reference System |

#### HasCoordinateOperation

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Cardinality</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>fCoordOperation</td>
<td>instance</td>
<td>1</td>
<td>Indicates conversion between coordinate systems. In particular it refers to an fCoordOperation between this coordinate reference system, and another Geographic coordinate reference system.</td>
</tr>
</tbody>
</table>

#### InheritedGRS

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Cardinality</th>
<th>Description</th>
</tr>
</thead>
</table>
| MapProjection | instance | ?           | Name by which the map projection is identified. Example: map projects include: 

  - UTM
  - Gauss-Krueger |
| MapZone | instance | ?           | Name by which the map zone, relating to the MapProjection, is identified. Example:

  - for UTM, this zone number, like 32 for UTM32
  - for Gauss-Krueger, the zones of longitudinal north, like ZI |
| MapUnit | instance | ?           | Unit of the coordinate axes composing the map coordinate system. Note: Only length measures are in scope and all such axes of the map coordinate system shall have the same length unit. |
### Attribute Inheritance

<table>
<thead>
<tr>
<th>#</th>
<th>Attribute</th>
<th>Type</th>
<th>Cardinality</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Name</td>
<td>IfcLabel</td>
<td></td>
<td>Name by which the coordinate reference system is identified. NOTE: The name shall be taken from the list recognised by the European Petroleum Survey Group EPSG. It should then be qualified by the EPSG name space, for example as &quot;EPSG:5515&quot;</td>
</tr>
<tr>
<td>2</td>
<td>Description</td>
<td>IfcText</td>
<td>?</td>
<td>Informal description of this coordinate reference system.</td>
</tr>
</tbody>
</table>
| 3  | GeodeticDatum                  | IfcIdentifier    | ?           | Name by which this datum is identified. The geodetic datum is associated with the coordinate reference system and indicates the shape and size of the rotation ellipsoid and this ellipsoid’s connection and orientation to the actual globe/earth. It needs to be provided, if the Name identifier does not unambiguously define the geodetic datum as well. EXAMPLE: geodetic datums include:  
  - ED50  
  - EUREF99  
  - WSG84 |
| 4  | VerticalDatum                  | IfcIdentifier    | ?           | Name by which the vertical datum is identified. The vertical datum is associated with the height axis of the coordinate reference system and indicates the reference plane and fundamental point defining the origin of a height system. It needs to be provided, if the Name identifier does not unambiguously define the vertical datum as well and if the coordinate reference system is a 3D reference system. EXAMPLE: vertical datums include:  
  - DHH/NG2: the German ‘Haupthöhennetz’  
  - ETR/92: the European Vertical Reference System |

*HasCoordinateOperation*  
IfcCoordinateOperation[@SourceCRS] S[0..1]  
Indicates conversion between coordinate systems. In particular it refers to an IfcCoordinateOperation between this coordinate reference system, and another Geographic coordinate reference system.
| MapProjection | IfcIdentifier | Name by which the map projection is identified.  
EXAMPLE map projects include:  
- UTM  
- Gaus-Krueger |
|---------------|---------------|----------------------------------|
| MapZone       | IfcIdentifier | Name by which the map zone, relating to the MapProjection, is identified.  
EXAMPLE  
- for UTM, the zone number, like 32 for UTM32  
- for Gaus-Krueger, the zones of longitudinal width, like 3° |
| MapUnit       | IfcNamedUnit  | Unit of the coordinate axes composing the map coordinate system.  
NOTE: Only length measures are in scope and all two or three axes of the map coordinate system shall have the same length unit. |

### 8.11.2.28 IfcIdentifier

- **Natural language names**

### 8.11.2.28.1 Semantic definitions at the type

- **Type definition**

  An identifier is an alphanumeric string which allows an individual thing to be identified. It may not provide natural-language meaning.  
  Type: STRING of up to 255 characters
### Attribute Inheritance

<table>
<thead>
<tr>
<th>#</th>
<th>Attribute</th>
<th>Type</th>
<th>Cardinality</th>
<th>Description</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SourceCRS</td>
<td>ItcCoordinateReferenceSystemSelect</td>
<td></td>
<td>Source coordinate reference system for the operation.</td>
<td>X</td>
</tr>
<tr>
<td>2</td>
<td>TargetCRS</td>
<td>ItcCoordinateReferenceSystem</td>
<td></td>
<td>Target coordinate reference system for the operation.</td>
<td>X</td>
</tr>
<tr>
<td>3</td>
<td>Eastings</td>
<td>ItcLengthMeasure</td>
<td></td>
<td>Specifies the location along the easting of the coordinate system of the target map coordinate reference system. NOTE: for right-handed Cartesian coordinate systems this would establish the location along the x axis.</td>
<td>X</td>
</tr>
<tr>
<td>4</td>
<td>Northing</td>
<td>ItcLengthMeasure</td>
<td></td>
<td>Specifies the location along the northing of the coordinate system of the target map coordinate reference system. NOTE: for right-handed Cartesian coordinate systems this would establish the location along the y axis</td>
<td>X</td>
</tr>
<tr>
<td>5</td>
<td>OrthogonalHeight</td>
<td>ItcLengthMeasure</td>
<td></td>
<td>Orthogonal height relative to the vertical datum specified. NOTE: for right-handed Cartesian coordinate systems this would establish the location along the z axis.</td>
<td>X</td>
</tr>
<tr>
<td>6</td>
<td>XAxisAbscissa</td>
<td>ItcReal</td>
<td>?</td>
<td>Specifies the value along the easting axis of the end point of a vector indicating the position of the local x axis of the engineering coordinate reference system. NOTE: for right-handed Cartesian coordinate systems this would establish the location along the x axis.</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NOTE: together with the XAxisOrdinate it provides the direction of the local x axis within the horizontal plane of the map coordinate system.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>XAxisOrdinate</td>
<td>ItcReal</td>
<td>?</td>
<td>Specifies the value along the northing axis of the end point of a vector indicating the position of the local x axis of the engineering coordinate reference system. NOTE: for right-handed Cartesian coordinate systems this would establish the location along the y axis.</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NOTE: together with the XAxisAbscissa it provides the direction of the local x axis within the horizontal plane of the map coordinate system.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Scale</td>
<td>ItcReal</td>
<td>?</td>
<td>Scale to be used, when the units of the CRS are not identical to the units of the engineering coordinate system. If omitted, the value of 1.0 is assumed.</td>
<td>X</td>
</tr>
</tbody>
</table>
Use of coordinates in IFC

Description of «The world coordinate system» common for the whole IFC file

8.7.3.9 IfcLocalPlacement

Natural language names

8.7.3.9.1 Semantic definitions at the entity

Entity definition

An IfcLocalPlacement defines the relative placement of a product in relation to the placement of another product or the absolute placement of a product within the geometric representation context of the project.

The IfcLocalPlacement allows that an IfcProduct can be placed by this IfcLocalPlacement (through the attribute ObjectPlacement) within the local coordinate system of the object placement of another IfcProduct, which is referenced by the PlacementRefTo. Rules to prevent cyclic relative placements have to be introduced on the application level.

If the PlacementRefTo is not given, then the IfcProduct is placed absolutely within the world coordinate system.
Challenges in GIS/BIM interoperability

- **GIS / GML:**
  - All positions given in defined Spatial reference system

- **IFC**
  - Positions given as local Cartesian coordinates
  - Local positions for each entity, relative to entity given in PlacementRelTo
  - Important geometric attributes given as parameters
    - Height, width, radius, ...

- IFC is fully dependent on coordinate systems with orthogonal axis and a common scale for all axis

- IFC is not suited where projects must handle earth curvation

- The challenge maybe more a matter of knowledge/awareness than of standardization.