IFC Infra Overall Architecture Project

Report WP1: Requirements analysis

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Overview

The anticipated scope of bSI standards for Infrastructure domain in long term covers constructed Civil engineering facilities other than buildings, and the necessary representation of Land features for the entire lifecycle of these facilities, including planning, design, construction, operation, maintenance and demolition. Anticipated types of facilities include roads, railways, waterways, airports, distribution networks (water, gas, district heating and cooling) and disposal systems (drainage, sewerage and solid waste systems), as well as landscaping and other outdoor facilities (such as for recreational activities).

The initial focus is targeted to support transport infrastructures: Road, Railway, Bridge and Tunnel facilities, including the Land features which provide the environment upon which these infrastructure facilities exist. This also includes support for topography (terrain) as well as subsurface information. Since infrastructure facilities often exist in geographic scales and contexts, bSI Infrastructure supports both geographic and local coordinate reference systems.

This limited scope is seen as necessary in order to meet the urgent need for transport infrastructure standards. However, in undertaking this work, every effort will be made to take cognisance of the anticipated broader scope described above.

As a basis for defining the overall architecture of IFC extensions for the infrastructure domain, the project team identified the most important uses cases of the data exchange processes in infrastructure projects. From these use cases, requirements regarding the neutral data model were derived. This neutral data model should be capable to present both semantic as well as geometric aspects.

To verify the importance of the use cases, a survey among the international Infra Room members was carried out. To this end, the project team initially defined 14 use cases. The importance of each of the identified use cases was then queried as part of the survey. This document describes the uses cases in detail, presents the outcomes of the survey and discusses the consequences for the next steps within the Overall Architecture project.

The defined use case list is not intended to be exhaustive. Instead, the most important use cases have been identified from prior interviews with experts having practical experience in infrastructure projects. The selection process was aimed specifically at identifying needs for specific geometry representations, as this would have a major impact on defining the overall architecture.

Use cases

No	Use case	Description	Purpose	IFC exchange scenario	Required geometry representation	Required semantic information	Survey rating	Priority use case (covered in the project)
1	Visualization	3D technical visualization of the infrastructure project	Communication of design solutions to third parties, including the public	Design application to Visualization app.	Tesselated BRep	Material (opt) Colors (opt)	7.38	yes
2	Coordination / Collision detection	Coordination of domain-specific sub-models	Transfer and combine models to detect interferences (clashes)	Design application to Design application	Tesselated BRep	Component type Classification	7.76	yes
3	4D Construction Sequence Modeling	4D technical visualization of the construction phases	Organization of construction site and construction activities	Design application to 4D scheduling application	Tesselated BRep	Temporal information	6.21	yes
4	Quantity Take-Off	Determine quantities (volumes and surfaces) from the model	Basis for cost estimation and cost calculation	Design application to QTO application	Tesselated BRep	Material, Classifications	7.36	yes
5	Structural Analysis	Structural analysis of bridges, tunnels, retaining walls	Ensure stability of the structures	Design application to structural analysis application	Analytical Model	Analytical Model	5.71	no

6	Drawing generation and exchange	Exchange technical drawings derived from the model	Submission to owner / regulation authorities	Design application to Submission	2D representation	All information relevant for drawing representation (line styles, symbolic representations, etc.)	6.33	no
7	Code Compliance Checking	Check design of railway / roadway for compliance with local codes and regulations	Compliance checking conducted by regulation authorities	Design application to checking application	Implicit description based on alignment and profiles	Information regarding the planned usage of the roadway/railway (velocities); Information regarding the applying regulations	6.24	no
8a	Design-to-Design (full model logic)	Exchange of fully parametric description of roadway / railway / bridge / tunnel between two distinct design applications	within the same design phase, design models are exchanged between different design applications, model remains fully modifiable, all model logic is transferred	Design application to design application	Fully parametric model information containing model logic, constraints and dependencies	All information entered in the design application	6.12	no
8b	Design to Design (reference model)	Check design of railway / roadway for compliance with local codes and regulations	Models are exchanged across different design phases, model from earlier phase is used us background /	Design application to design application	Implicit description based on alignment and profiles	Classification Material Component types	- [1]	yes

[1] was not covered in survey, but identified as required use case through a-posteriori expert interviews

			<u>reference model</u> for next phase					
9	Machine control	Usage of model information for control / steering of machines such as graders etc.	Partially automated construction of the roadway / railway	Design application to machine	Implicit description based on alignment and profiles	(specific)	5.67	no
10	Progress Monitoring	Transfer information about the progress of the construction project	Track and document the progress of the construction project	Surveying application to visualization application	Tesselated BRep	Temporal information	6.07	yes
11	As-built vs. as-planned comparison	Compare the built structure against the as-planned model	Check the quality of the construction (on site)	Design application to field application	Tesselated BRep	Classification Tolerance values	6.02	yes
12	Operation and maintenance	use the model to support operation and maintenance of the infra-structure asset, including	use the model for inspection, damage detection, condition rating, condition prediction, maintenance planning	Design application to maintenance management system	Tesselated BRep	Classification Material Maintenance information	7,17	yes
13	Exchange from/to GIS		GIS (and other) data provides the basis for the design task	GIS system to Design application / Design application to GIS system	Implicit description based on alignment and profiles	Major design parameters	6,81	yes
14	Initial State Modeling	initial data (terrain, soil, existing structures etc.) from various GIS	GIS (and other) data provides the	GIS & other sources to design application	Implicit description based on alignment and profiles,	Major design parameters, Material (soil classification),	6,83	yes

		(and other sources) are brought into BIM space and can then be exchanged using IFC	basis for the design task		Tesselated BRep for terrain	accuracy and reliability of initial data		

Detailed Survey Results

as per April 29th, 2016

Answer Options	1	2	3	4	5	Rating Average	Response Count
2. Coordination / Collision Detection	1	4	3	14	20	7,76	42
1. Visualisation	1	5	6	12	18	7,38	42
4. Quantity Take-Off	1	5	5	14	17	7,36	42
12. Operation and maintenance	2	5	6	12	17	7,17	42
14. Initial State Modelling	0	2	13	18	9	6,83	42
13. Exchange from / to GIS	1	7	5	17	12	6,81	42
6. Drawing generation	3	4	9	18	8	6,33	42
7. Code compliance checking	2	4	14	14	8	6,24	42
3. Construction Sequence Modelling (4D Modelling)	2	7	10	14	9	6,21	42
8. Design-to-design	1	8	13	11	9	6,12	42
10. Progress monitoring	0	8	14	13	7	6,07	42
11. As-built vs. As-planned comparison	1	7	11	18	5	6,02	42
5. Structural Analysis	3	5	17	11	6	5,71	42
9. Machine control	2	10	14	8	8	5,67	42
15. Other (please add a short description)							6
						answered question	**42**
						skipped question	**0**

Consequences

Based on the outcomes of the survey and discussion within and beyond the project team, the project team decided to prioritize the following use cases for explicit consideration when designing the IFC Overall architecture:

- Visualization
- Coordination / Collison Detection
- Quantity Take-Off
- Exchange from/to GIS
- Operation and maintenance
- Design-to-Design (Reference Model)
- Initial State Modeling

In addition, the following uses cases will be covered as they can be realized on the basis of standard IFC capabilities:

- 4D modeling
- Progress monitoring
- As-built vs. as-planned comparison

Out of scope for this project are:

- Drawing generation
- Structural analysis
- Code Compliance Checking
- Machine control
- Design-to-Design (Full model logic)

Appendix A depicts the dependencies between the use cases.

It should be noted that this does not mean that these use cases (and others not mentioned here) cannot be covered by specific IFC-Infra extensions (IFC-Road, IFC-Rail, IFC-Bridge, IFC-Tunnel, etc). However, they will not be in scope for this project when defining common data structures for representing the geometry, the spatial structure and the positioning.

Most importantly, the identified use cases all require either explicit BRep geometry based on tessellation or implicit geometry based on the alignment, profile and super-elevation. This outcome allows to focus on these two geometry representations when defining common data structures. While the former can be defined using existing IFC entities, the latter requires specific extensions to be defined in this project.

It has to be noted in particular, that the full design-to-design use case which incorporates the model's design logic, is excluded here as it would require a major effort from both bSI in defining the necessary data structures and from the software vendors in correctly implementing them. Currently, there is no well-defined industry need that would justify this effort.

The identified use cases help to limit the project scope, however the project will not support the use cases in their entirety. Instead, the project is focusing on what is common in the use cases across the various subject areas.

Next Steps

The project team will start to define the common data structure to be used in all future IFC-Infra extensions in the following areas:

- implicit geometry representation based on alignment and profiles
- geometric description of cut and fill
- common spatial structure for infrastructure facilities

The project team will do so by taking into account the use cases identified above as well as the proposed data structures by the Korean IFC-Road project, the Chinese IFC-Rail project and the French IFC-Bridge project and the Japanese IFC-Tunnel project, The team will demonstrate that the designed data structures allow to fulfill the requirements of the use cases and support the corresponding data exchange scenarios.

Outlook

The IFC Overall Architecture Project is based on the following assumptions regarding the future development of the IFC data model with respect to its capabilities to represent and transfer data for designing, constructing and operating infrastructure assets:

- There will be a limited number of domain-specific extensions (5-8) based on the common data structures and modeling guidelines defined in this project. The extensions known today are IfcRoad, IfcRail, IfcBridge and IfcTunnel.
- IFC-Infra as an international standard will provide mostly generic descriptions of infrastructure facilities. It will focus on sound geometry definitions that allow a precise

and rich transformation of geometry definitions. It will also provide semantic definitions (types and attributes) which are suitable within an international context. Since however, a large share of the semantic information is related to national standards and regulations, corresponding extensions mechanisms like Object Type Libraries or property set definitions will have to be applied on a regional/national/local level.

- A very promising technology can be seen in the Linked Data approach. It allows to link objects of the IFC-Infra data model with objects of any external data schema. In this way also use cases not directly covered by the IFC-Infra extensions can be realized using integration on a high semantic level.

Taking these predictions together, it will be possible to define the IFC-Infra Overall Architecture in a way that it provides both a solid common ground for the IFC infra extensions as well as sufficient flexibility to cover specific requirements arising in the future.

Annex A Use case dependencies