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# Infrastructure projects

This document describes the contribution of the Infrastructure room to the buildingSMART 2016 strategic roadmap and to the appendix highlighting the high priority projects.

## Business Case

**Opportunities**: Enable the use of BIM for infrastructure work for the goal of based on the same goal “improvements in cost, value and carbon performance through the use of open sharable asset information, and the same principles, including “valuable, understandable, general, non proprietary, competitive, open, verifiable, and compliant”.

**Opportunity statement**: Infrastructure projects are predominately large projects with high capital investments and long inception, planning, execution and operation periods. Achieving the opportunities to implement an open BIM way of working for infrastructure projects would contribute disproportionately high to the overall goal of improvements in costs and values.

**Business objectives**:1) Identification of high-value use cases for early implementation of BIM in infrastructure projects,

2) Open, non-proprietary standards for data drops and handover in infrastructure projects for important infrastructure disciplines (level 3)

3) Identify verifiable content and quality criteria utilizing open standards for the project stages, both for hand-over and for collaborative work

**Potential Impact**:Availability of open standards, verifiable information completeness and quality criteria, and clear guidance on its value for project management and operation of the infrastructure assets enables the government pull for BIM based infrastructure project delivery.

Identification of high-value use cases and work with solution providers to deliver the right IT tools to the project participants, and methods and guidelines of implementation and use activates the supply chain to push towards BIM in infrastructure.

## Project objectives

**Overall objective**: Completion of the virtual construction schema to cover the most important areas for infrastructure and external works.

* + - * Based on clearly identified use cases expanding the international standard, ISO 16739 (IFC), and other related standards,
      * Modular delivery of its main schema components (terrain, ground strata, road, rail and water ways, bridges, tunnels, public utilities) while maintaining the common components,
      * Identification of main concepts required for data drops, handover and collaborative work and how information quality and completeness rules are to be captured,
      * Establishing the framework to support solution providers for the implementation and certification process.

## Project breakdown

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Main task** | **Begin** | **End** | **Person years** | **Comments** |
| **Infrastructure extensions project** | **Jul-13** | **Dec-16** |  |  |
| ***overall project management*** | **Jul-13** | **Dec-16** | 3 |  |
| ***Scoping the overall work*** | **Jul-13** | **Dec-13** | 1 |  |
| ***General technical update on IFC standard*** | **Jul-13** | **Jun-14** | 2 |  |
| Technical readiness | Jul-13 | Dec-13 |  |  |
| parametric definitions | Jan-14 | Jun-14 |  |  |
| ***Fast track (Quick-win) scenario's*** | **Jul-13** | **Sep-14** | 3 |  |
| Define IFC-Bridge as fast track | Oct-13 | Sep-14 |  |  |
| ***User requirement definitions*** | **Jul-13** | **Jun-15** | 4 |  |
| Identify high-value use cases | Jul-13 | Mar-14 |  |  |
| Facilitate stakeholder workshops for each use case | Apr-14 | Jun-15 |  |  |
| ***Standard data definitions and terms*** | **Jul-14** | **Jun-15** | 4 |  |
| Modular IFC integration of use cases (terrain, ground strata,   road, rail and water ways, bridges, tunnels, public utilities) | Jul-14 | Jun-15 |  |  |
| ***Completion of virtual construction schema (IFC extensions)*** | **Jan-15** | **Dec-16** | 8 |  |
| Staged modular delivery process (terrain, ground strata,   road, rail and water ways, bridges, tunnels, public utilities) | Jan-15 | Mar-16 |  |  |
| Finalization as new IFC5 release (bSI standard deliverable) | Apr-16 | Dec-16 |  |  |
| ***Support the implementation and validation process*** | Jan-15 | Dec-16 | 7 |  |
| Concepts, validation rules and model views (terrain, ground strata,   road, rail and water ways, bridges, tunnels, public utilities) | Jan-15 | Jun-16 |  |  |
| Support the implementation by solution providers | Jul-15 | Dec-16 |  |  |
| ***extended project management*** | **Jan-17** | **Dec-18** |  |  |
| ISO final ISO16739 second edition delivery | Jan-17 | Dec-18 | - | t.b.d. |
| Certification | Jan-17 | Dec-18 | - | t.b.d. |
|  |  |  | **32** |  |

# Strategic goal and activation of resources

Achieving the project objectives that require international support in terms of knowledge input and harmonization with other activities the support of two main groups of the organization should be ensured:

## The Infrastructure Room of buildingSMART International

The purpose of the Infrastructure Room within buildingSMART International is to support the process of defining the requirements and the implementation (or extension) of standards for supporting BIM (or Virtual Design and Construction, VDC) processes for the civil and infrastructure sector of the construction industry. The Infrastructure Room is established within buildingSMART International.

Establishing an own room allows to establishing a new direction of buildingSMART user oriented and technical development projects that focuses solely on the civil and infrastructure sector, whereas the other established rooms will continue to enhance the buildingSMART open BIM developments for the building engineering sector.

Note: At the moment the existing buildingSMART International project groups, Product room, Process room, and Technical room are building oriented. The Infrastructure room will offer the possibility to verify for the infrastructure sector, which developments executed by the process, product, and technology rooms could be adopted and which has to be extended or newly developed.

BIM (or VDC) for infrastructure has to be seen as new work items, that takes the particular requirements of infrastructure construction into account, while reusing many of the well established solutions for BIM for buildings. It is therefore seen as an adaptation, extension and partially new development of BIM for the infrastructure sector.

The existing standards developed by buildingSMART are key and baseline elements also for the development of BIM for infrastructure.

The tree main buildingSMART standards for process, data and terms

One of the first goals of the Infrastructure Room is to identify a roadmap of necessary standard developments and process guidelines to better support the infrastructure sector. Those have to have a common basis, but also need to take into account the specifics of the various sectors within infrastructure, like bridge, road, tunnel, geological (strata) and others.

## The Model Support Group of buildingSMART International

The Model Support Group - MSG of buildingSMART International is a group of internationally recognized experts from buildingSMART membership that builds and maintains buildingSMART data model standards. MSG is responsible for the development and maintenance of the IFC specification and related specifications. The Industry Foundation Classes - IFC are the main technical deliverable of buildingSMART in order to fulfill its goal to promote openBIM.

The main objective of MSG is to continuously develop, improve and maintain the IFC specification and to support its implementation in IFC compatible software. In addition, MSG is responsible for coordinating the Model View Definitions - MVD i.e. the definition of subsets of IFC to support certain data exchange and sharing use cases, or exchange requirements. It also included the addition of business rules into the MVD for validation of data submissions against the exchange requirements.

The development of BIM standards for infrastructure shall include the same triangle of standard developments already successfully applied to building engineering – process, data, terms.

# Scoping the overall infrastructure developments

The important task of the Infrastructure Room is to scope, steer and coordinate the necessary development steps for openINFRA – the buildingSMART coordination project, the roof, under which the various infrastructure BIM standardisation project should be organized. The overall coordination includes:

* The definition of the high-priority use cases, leading to Information Delivery Manuals capturing the stakeholders’ requirements,
* The definition of open INFRA data models, mainly leading to the next major IFC5 release, including modules for bridge, road, site and earth strata, tunnels[[1]](#footnote-1), but also as a short term solution included an extension to LandXML,
* The definition of a dictionary of terms for infrastructure domain that is integrated into the buildingSMART data dictionary.

In addition, the collaboration with the Open Geospatial Consortium is sought to coordinate the infrastructure standardization efforts, in particular where the classic BIM and GIS domains overlap.

## Use case definitions

As a starting point the high level use cases for infrastructure have to be defined. A starting point are the initial 40 BIM use cases defined by buildingSMART for building engineering, but only some could be considered as relevant for infrastructure, others need to be added.

Some crucial use cases are not covered yet, or need to be extended:

* environmental assessment
* road and bridge alignment
* acoustic assessment, noise distribution
* geological assessment, ground strata
* communication with third parties for urban and landscape planning
* many others

## Stakeholder workshops for use case definitions

In order to develop the use case definitions, stakeholder workshops should be arranges, where the various stakeholders of infrastructure projects, together with buildingSMART specialists for process, data and dictionary modelling, should come together to define the use cases in terms of process maps and exchange requirements.

Several individual stakeholder workshops have to be set-up by domains:

* Environmental planning,
* Geotechnical (earth strata),
* Linear construction structures such as:
* Bridges,
* Road ways,
* Rail ways,
* Tunnels,
* Utility networks,
* Drainage, etc.

The goal is to identify the domain requirements for data and terms by each domain.

As real infrastructure projects often involve more than one domain, the cross-domain requirements have to be defined in parallel to the stakeholder workshops. The final infrastructure data model has to include various modules to enable the combination of all domains model.

The outcome of the stakeholder workshops, and the cross-domain summary and integration will deliver:

* A series of Information Delivery Manuals (IDM), including the process maps and exchange requirements for the infrastructure BIM data,
* A definition of the various Level of Details (LoD) of that BIM data depending on the project phases[[2]](#footnote-2)
* A workflow management process using BIM workflow for the project management process of infrastructure projects[[3]](#footnote-3).

## Capturing the definition of terms and data requirements

The exchange requirements are the basis of defining the data dictionary to capture the definition of terms. It still has to be clarified, how the dictionary can be used to develop and to structure the data terms. The work has to be done in conjunction with the development of the data schema as the physical capture of infrastructure BIM models and the libraries for infrastructure.

This focus has to be considered as the basement to identify the needs for the IFC extensions required for the various infrastructure domain schemas in a coordinated way.

The outcomes of this process are:

* The development of the dictionary of terms (semantic definitions, attributes and relation)
* The Infrastructure room will have to identify what has to be developed by the Infrastructure room, and what it has to be done within Product room or in accordance with it.

## Developing the new open INFRA IFC Extensions

Based on the outcome of the stakeholder workshops and the capturing of terms and data requirements the various domain specific infrastructure extension modules are developed. Based on the cross-domain considerations, a common layer of a general infrastructure schema has to be developed before.

Note: The alignment curve is a central part of all infrastructure models (bridges, roads, tunnels), therefore it has to be developed once, and referenced in all relevant infrastructure modules.

The Infrastructure modules will be based on the current IFC model architecture, and many generic IFC features are reused, e.g. geometry, property sets, feature code, library and classification links, etc.

There are three areas already identified, where most of the extension work has to concentrate at:

Product breakdown structure:

* Infrastructure object already defined by current IFC product catalogue (e.g. pipes for drainage)
* Infrastructure object can be considered as an extension of a product class (e.g. piers or decks)
* Infrastructure object cannot be considered as an extension (e.g. dig and fill for earthworks).

Spatial reference system:

* Linear infrastructure projects (like roads, bridges) follow a different spatial structure than buildings, a new spatial reference system needs to be developed

Alignment system

* Linear infrastructure projects have objects aligned to a reference (or alignment) curve, a different concept to buildings having local placements to a building or story origin. The alignment structure needs to be developed.

The development of data schema extensions for infrastructure will be broken down into:

* Common infrastructure extensions
* IFC extension definitions of use case (to focus directly on exchange requirements)
* IFC module integration into the common IFC architecture

When scoping the IFC extension definitions of use cases there is a need to determine priorities based on stakeholder requests and “pain points”, we need to “identify quick wins and long term strategy”.

## IFC Bridge as fast track project

The first quick win extension work has already been identified as IFC Bridge. It can be based on an existing work and stakeholder involvement, and a pre-integrated IFC Bridge schema already exists.

The IFC Bridge will be developed in accordance with the first conclusions of a serious of stakeholder workshops that took already place to:

* To verify and to complete the existing model
* To develop the monitoring of a such workshop by the Infra room

In the first round, the IFC Bridge schema will focus on bridge modelling as a separate workflow, the future developments will include the connections to road and other domains.

## Link to or engagement in other standardisation projects

LandXML – a separate project started to develop an extension to LandXML based on the existing LandXML schema with questions, like “What is relevant in LandXML, what is missing, what it has to be dropped”.

CityGML – it is important to identify the relationship to connect an IFC model with CityGML.

This project has to be seen as a project developed in partnership with the OGC in order to avoid double specifications and double data dictionary developments.

# Initial project plan

The following project plan is an initial breakdown of the required development steps and the (optimistic) time line, by which those tasks could be achieved. The realisation requires substantial commitments by stakeholders and external resources to fulfil the tasks. A more detailed project breakdown with required resource allocations will be developed.



Initial project plan for the Infrastructure Room to deliver openINFRA buildingSMART Standards

<to be updated>

Appendix A : Horizontal and vertical alignment in Infrastructure

Until now, the only one way to describe, under regulation, a linear infrastructure, is to describe a reference line from an horizontal alignment and vertical alignment. All the checking, according to the regulation, is based on horizontal, and vertical alignment and superelevation. Normally, the BIM for infrastructure in the future will have to modify this point to propose model checker based on Bim solutions.

More or less, the horizontal alignment is the XY projection of the 3D curve and the vertical alignment is a very special projection of the 3D curve in Chainage (or station) (replacing the X) and Z (replacing the Y).

This line is known on each point in XYZ ( geo-reference), chainage (or station). Chainage (or station) is not always starting at 0. The chainage’s progress is not always arithmetic. The operation’s chainage is different to the design’s chainage. The vertical alignment’s chainage is defined by the horizontal alignment. When the design of the horizontal alignment is changing, the design’s chainage is changing. But, may be not for the operation chainage.

An horizontal alignement contents : strait line, circle and spirale (clothoid) to connect strait line and circle. The spirale represents the distance for the driver to turn his wheel.

A vertival alignment contents : strait line and curve (parabellum or circle). The curve is connecting strait lines. Normaly a vertical alignment is continue. For one chainage, there is only one Z.

A centerline is not always on the center of the carriageway. The vertical alignment is not always on the centerline. But the superelevation is always centered on the vertical alignment.

For the road and railway, part of the shape (the 3D solid) is providing by the centerline in 3D: the cross section’s template running along the centerline. Like a P.H., including parametric conditions related to the centerline. But part only. The surface of the cut and fill are not defined by others parametric conditions, related to the site.

For the road and railways ( including canal ) the centerline is a key element for :

* + The geometrical definition ( the final 3D solid shape)
  + The location definition : the relationship between XYZ and Chainage and offset. ( an object can be located in XYZ, or/and chainage + nnn and offset from the centerline

For bridges or tunnels the centerline is a key element for:

* + The location definition and interface with the road and the railway
  + Very few element of the geometrical definition is related to the centerline.

Appendix B : IFC Bridge as fast track project

-The IFC bridge has to be seen in two parts:

* To develop the IFC Bridge model in order to develop the interoperability with the different stakeholders designing and constructing the bridge. The basement of IFC Bridge are the IFC model IFC4 and the IFC Bridge model .
  + The usecases are :
    - designer to structure analysis
    - designer to contractor (procurement)
* To develop the infra model in order to insert the bridge inside the infra :
  + the question of the centerline is part of this issue, mainly to introduce the chainage in the bridge design.
  + the object on the interfaces on each part ( links with the cut or the fill) cannot be defined as an IFC feature ( to be confirmed
  + But Most of the bridges shapes (geometry) is not related to the centerline.
  + Even the pavement for most of the bridges can be defined, at the moment with ifc features or ifc bridge features.
  + The use cases are :
    - bridge designer to infrastructure project manager
    - Infrastructure project manager to bridge designer
    - Infrastructure project manager to bridge contractor (procurement)

1. The particular steps required to develop the buildingSMART open BIM data model for infrastructure as the major extension projects leading to IFC5 release, are described in the attachment document developed by buildingSMART MSG, Thomas Liebich, as IFC for INFRA Project. [↑](#footnote-ref-1)
2. A baseline definition of the LoD’s should be based on OGC developments, e.g. in CityGML. [↑](#footnote-ref-2)
3. For reference (translated from French)

   http://www.communic.fr/Telechargement/Projet%20ARN%20communic/Communic%20L1%20-%20Global%20Model.pdf [↑](#footnote-ref-3)