Appendix 1

Final report

INDUSTRY PRACTICES FOR APPLICATION OF COCLASS IN SOFTWARE

SMART BUILT ENVIRONMENT

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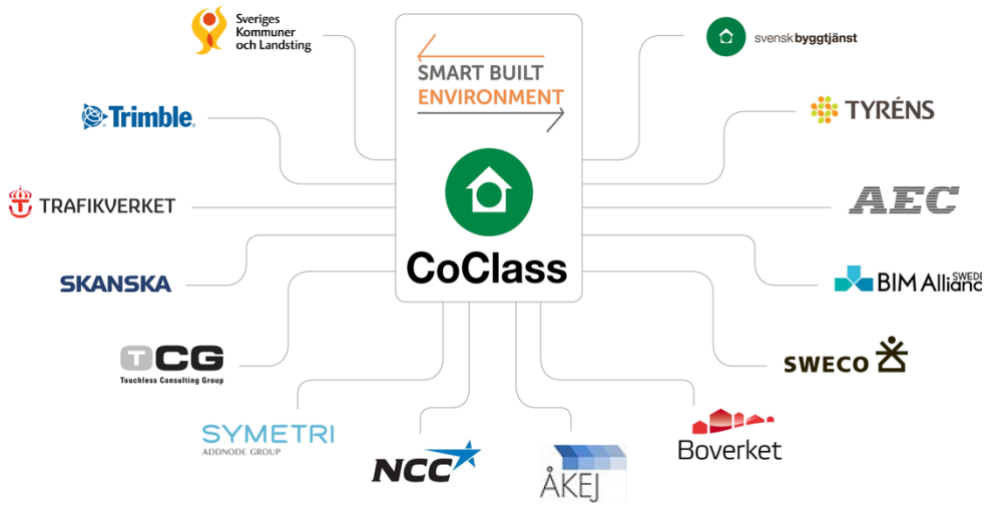

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Preface

Smart Built Environment is a strategic innovation program for how the built environment sector can contribute to Sweden's journey towards becoming a global pioneer that realizes the new opportunities that digitalization brings. Smart Built Environment is one of 16 strategic innovation programs that have received support within the framework of *"Strategiska innovationsområden"*, a joint venture between Vinnova, Energimyndigheten and Formas. The purpose of the initiative is to create conditions for Sweden's international competitiveness and contribute to sustainable solutions to global societal challenges.
The community building sector is Sweden's single largest sector that affects our entire built environment, but it is fragmented with many actors and processes. Changing community building with digitization as a driving force therefore requires collaboration between many different actors. Smart Built Environment takes a comprehensive approach to the opportunities that digitalization entails and becomes a catalyst for the spread of new opportunities and business models.
The program aims to achieve by 2030:

- 40% reduced environmental impact in a life cycle perspective for new construction and renovation
- 33% reduction of total time from planning to completion for new construction and renovation
- 33% reduction in total construction costs
- several new value chains and business models based on life cycle perspectives, platforms and new constellations of actors

In the program partners from the business sector, municipalities, authorities, industry and interest organizations, institutes and academies collaborates. Together, we utilize the knowledge that is produced in the program. *Industry practices for application of CoClass in software* is one of the projects that have been implemented in the program. It has been led by *AB Svensk Byggtjänst* and has been implemented in collaboration with the following co-financiers: AEC Advanced Engineering Computation Aktiebolag, Touchless Consulting Group AB, Trimble Solutions Gothenburg AB, Sweco Position AB, Symetri AB and ÅKEJ AKTIEBOLAG

Stockholm, 2019-06-18

Summary

The purpose of the project have been to develop Industry practices, ie guidelines and recommendations, for how CoClass should be applied in software in a uniform way over the life cycle in order to contribute to achieving an uninterrupted information flow where information is not lost along the way.

Based on the stated needs and requirements of a large number of relevant stakeholders in the built environment sector, a number of use cases were developed. Several proof-of-concept implementations were then developed in order to test the possibility to use CoClass as a carrier of the information in these use cases.
Based on the project work, joint Industry practices have been developed that describes how CoClass is to be implemented in software in order to ensure a common way to handle CoClass and its components.

Sammanfattning

Syftet med projektet har varit att utveckla en branschpraxis, dvs. riktlinjer och rekommendationer, för hur CoClass ska tillämpas i programvara på ett enhetligt sätt under livscykeln för att bidra till att uppnå ett oavbrutet informationsflöde där information inte går förlorad längs vägen.

Baserat på de angivna behoven och kraven hos ett stort antal berörda aktörer inom samhällsbyggnadssektorn utvecklades ett antal användarfall. Därefter utvecklades flera proof-of-concept-implementeringar för att testa möjligheten att använda CoClass som bärare av informationen i dessa användningsfall.
Baserat på projektarbetet har en gemensam branschpraxis utvecklats som beskriver hur CoClass ska implementeras i programvara för att säkerställa ett gemensamt sätt att hantera CoClass och dess komponenter.

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1 Background, purpose and scope

1.1 Background

CoClass is a modern and web-based classification system that is developed to cover the built environment's complete information need. CoClass builds on international standards and on proven experience.
The vision is that CoClass shall lead to improved communication between the actors within the built environment. The goal is that CoClass shall be used by all parties during all stages during the lifecycle of a construction complex from early stages to maintenance, operation and demolition. A survey conducted 2014 by Svensk Byggtjänst showed that deficient communication leads to increased spending of approximately sixty billion SEK within the built environment. CoClass may contribute to the resolution of this problem when used fully through the whole lifecycle. In other words, there is a substantial potential for savings for the sector when using CoClass.
A strive is that CoClass successively will replace the current system for classification, BSAB 96. CoClass is adapted for digital modelling and will play an important role in the realization of the full potential with BIM (Building Information Modelling). CoClass includes definitions for objects, properties and activities through the whole lifecycle for both buildings and infrastructure. This will be the backbone for the communication through the construction, maintenance and operation, from idea to demolition.

1.2 Purpose of the project

One important component to achieve the potential of CoClass is that there exists support in the software systems that are used in different stages through the life cycle. This is vital for achieving a continuous flow of data through the processes thus reducing the risk of misunderstandings and disputes and errors. Adequate support in software will also significantly lower the thresholds for getting started.
To achieve this, it is required that the software which implements CoClass does this in a uniform way. The understanding of CoClass is not allowed to change just because different software systems are used in different parts of the lifecycle.
The purpose of this project is therefore to develop guidelines and recommendations for how CoClass shall be implemented in software.
Primary purpose:

- To develop an industry practice for software implementors on how to implement CoClass in a uniform way.

Secondary purpose:

- To provide an opportunity for software implementors and other actors in the built environment to put forward requirements on functionality and content in CoClass.

Tertiary purpose:

- To achieve software implementations with built in support for CoClass so that CoClass users can include the use of CoClass as part of their information delivery specifications.

1.3 Scope and delimitations

The project is limited to the needs, requirements and practices of:

- The implementation of the CoClass API provided by Svensk Byggtjänst
- Transfer of data between the aforementioned API and the applications that wish to use CoClass
- Use of CoClass data in a number of typical applications based on user needs

The report does not describe or define how the CoClass classification system works, or how the classification should be used.
Because of the limited time and resources of the project, this report and the corresponding Industry practices is only a start on the work that needs to be done in order to successfully implement CoClass throughout the built environment.

1.4 Reading notes

For information about the project, read this project report.
For information on the Industry practice and how to implement CoClass in software, read *Industry practices for application of CoClass in software*. For information on Svensk Byggtjänst's products CoClass Studio, the CoClass API and how to utilize them, read *Appendix 2 – CoClass Studio and API*. For a list of definitions used in these documents, read *Appendix 3 – Definitions*.

1.5 Definitions

During the project, a list of definitions has been produced, with relevant concepts and the definitions the project has agreed upon.
They are a combination of definitions from standards, national guidelines, concepts used in CoClass Studio and API, and other concepts deemed important by the project. The list of definitions can be found in *Appendix 3 – Definitions*.

2 Prerequisites

CoClass is based on the following international standards:

- SS-ISO 12006-2:2015, Building construction – Organization of information about construction works – Part 2: Framework for classification
- IEC-EN 81346-1:2009 Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations – Part 1: Basic rules
- IEC 81346-2:2019 Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations – Part 2: Classification of objects and codes for classes
- ISO 81346-12:2018 Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations – Part 12: Construction works and building services

3 Summary of work in the project

The project has been based on a series of previous projects. The work was conducted in a number of work packages (AP) with associated decision points (milestones). There are strong links between the work packages and based on later work the results in earlier work packages were refined.

3.1 Earlier work

The project takes its start from several projects that have been carried out within the Smart Built Environment program. Below is a short summary of three of main projects that have had large impacts on CoClass, and how it should be implemented within the built environment.

3.1.1 Development of classification for BIM BSAB 2.0

The new classification system for all built environment in Sweden – CoClass – is a result of an extensive industry-wide development project called BSAB 2.0.

The system has the potential to improve information management in the construction and asset management sector.

More effective communication throughout the construction – and maintenance process can save billions. A survey conducted in 2014 by the Swedish Building Centre shows that lack of communication leads to more expensive production with about sixty billion SEK annually. CoClass can help solve part of this problem if used fully throughout the lifecycle. Classification is a prerequisite for better communication.

CoClass covers the entire built environment, with classes ranging from airports and residential areas down to the last screw.

CoClass will gradually replace the current system for classification, BSAB 96. CoClass contains objects, descriptions of objects, properties and activities throughout the life cycle of buildings and facilities, in Swedish and in English.

3.1.2 Verification of IFC Alignment & InfraGML (VERA)

The project "Verification of IFC Alignment & InfraGML" (https://www.smartbuilt.se/projekt/standardisering/verifiering/) was executed during 2017. The main purpose of the project was to verify that these standards can be implemented in existing software packages in the infrastructure sector and that data exchange works smoothly without any loss of information. As a separate activity, the project investigated how CoClass may be referenced when using IFC or InfraGML for file-based data exchange. The purpose for this would of course be to provide a CoClass classification for the objects represented as either IFC Objects or InfraGML objects.
The main conclusions were the following:

- It is possible to reference CoClass from both these formats
- There is a need to provide guidance on how this shall be done in the future
- To achieve unambiguous and machine interpretable references to CoClass, it is questionable if the CoClass code itself provides enough context since it is basically only a string of a few characters. IFC have ways to reference the actual classification system as a whole (through IfcRelAssociatesClassification), but InfraGML has not.
    - To address this issue, the VERA project suggested a method where CoClass is made available through linked data and semantic web technologies where each class in CoClass may be referenced using a resolvable internet URI directly linking the corresponding CoClass concept. This way, CoClass may be easily referenced from objects in any of these formats (and

many other formats) in an unambiguous and machine-interpretable fashion. The codes may still be a viable option for other use cases.

- The use of reference designations together with IFC and InfraGML should be further investigated. Both formats (IFC & InfraGML) have their way of breaking down a project or facility in a hierarchical fashion and there may be a risk of redundancy in the representation of these hierarchies when also using reference designations.

3.1.3 CoClass and LOD

The purpose of project *CoClass and LOD* was to verify that CoClass supports the need and flow of information during all stages of the life cycle of a construction entity. As a step in that direction, a description of how to designate information deliveries is provided.

The aim has not been to describe long-term asset information management in concrete terms. For this, issues concerning e.g. quality of data, object identification, and maintenance strategies are paramount. For this, more development is needed.

Through a case study of a complex site – Odenplan in Stockholm – the ambition has been to simulate needs and exchange of information in the interface between different construction entities and actors. The case study is presented using 3D, AR-, and VR models.

Through these simulations, it can be concluded that CoClass works well as carrier of relevant information. The basis is a combination of functional object classes and well-defined properties. These are linked to additional information concerning material, product properties and more.

The goal should be a de-centralized storage of data. Geometrical models – e.g. CAD files – should contain a minimum of alphanumerical information, except for an unambiguous identification of each object. From such a reference designation, a stable connection can be made to external data.

The need for information varies through the life cycle of a built object. Every delivery of an information set needs to be adapted to the current need. As an identifying designation of an information set, the concept of *information level* is suggested.

Information level is suggested to be a three-digit designation, where the first digit indicates *life cycle stage*; the second indicates *level of complexity*; the third indicates *purpose*. In order to coordinate with coming European standard, the acronym LOIN (*level of information need*) is proposed. This will supersede the acronym LOD, which should revert to the original *level of (graphical) detail.*

3.2 Project work

The project's work followed the following process:

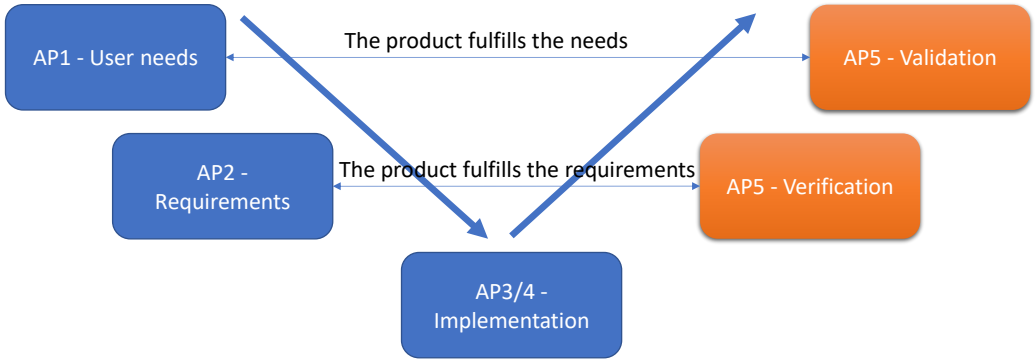

Figure 1 – Project process

In work package 1, workshops with the aim to investigate user needs, were held together with user representatives. The results from this investigation of user needs is reported in (*Project Industry practices for application of CoClass in software - AP1, 2019*).

The results from this investigation have been compiled into a requirements analysis (*Project Industry practices for application of CoClass in software - AP2, 2019*), together with requirements from the participating software providers to capture a representative set of requirements from a large group of stakeholders. Based on this, work packages AP3, reported in (*Project Industry practices for application of CoClass in software - AP3, 2019*), and AP4, reported in (*Project Industry practices for application of CoClass in software - AP4, 2019*), was executed.

The results of the verification and validation performed in work package 5 (AP5) based on the specified, implemented and tested cases is summarized in (*Project Industry practices for application of CoClass in software – AP5, 2019*).

Based on previous work packages, the AP6 work consisted of analyzing this information and summarizing it into a Industry practice. The Industry practice is found in *Appendix 1 – Industry practice for application of CoClass in software*.

4 Lessons learned

Throughout the projects, several lessons learned were identified.

- Further work – the project has identified several areas, both small and large, that needs future work. These have been collected and summarized in the Industry practices.
- Decentralized project – the project has been carried out decentralized, which poses unique challenges. It is important with continuous and frequent communication in this type of project.
- Changes throughout the project – the iterative nature of the project has made it necessary to change the plan, the content and the results continuously. It is important to realize that this is natural in this type of project, and plan accordingly.
- Future platform for the Industry practices – in order to ensure the success of implementing CoClass in software, the need for a future platform for developing the Industry practices and its consequences on CoClass has been identified. A proposal for this has been outlined in the Industry practices.
- Commonality – it is important that everyone implements CoClass in a common way to ensure interoperability.

5 References

(2019). *IEC 81346-2:2019 Industrial systems, installations and equipment and industrial products - Structuring principles and reference designations - Part 2: Classification of objects and codes for classes.* IEC.

(2009). *IEC-EN 81346-1:2009 Industrial systems, installations and equipment and industrial products - Structuring principles and reference designations - Part 1: Basic rules.* IEC.

(2015). *ISO 12006-2:2015, Building construction - Organization of information about construction works - Part 2: Framework for classification.* ISO.

(2018). *ISO 81346-12:2018 Industrial systems, installations and equipment and industrial products - Structuring principles and reference designations - Part 12: Construction works and building services.*

Project Industry practices for application of CoClass in software - AP1. (2019). *L1 - Slutrapport behovsanalys.*

Project Industry practices for application of CoClass in software - AP2. (2019). *L2 - Requirements specification.*

Project Industry practices for application of CoClass in software - AP3. (2019). *L3 - Implementation specification.*

Project Industry practices for application of CoClass in software - AP4. (2019). *L4 - Implementation.*

Project Industry practices for application of CoClass in software - AP5. (2019). *L5 - Verification and Validation.*

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