

L5: Verification and validation protocol

INDUSTRY PRACTICES FOR APPLICATION OF COCLASS IN SOFTWARE



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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 construction sector's complete information need. CoClass builds on standard, science and proven experience since it is based on international standards (see Normative references section)

The vision is that CoClass shall lead to improved communication between the actors within the construction sector. 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. An investigation performed 2014 by Svensk Byggtjänst showed that deficient communication leads to increased spending of approximately 60 billion SEK within the construction sector. 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 construction sector 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 Purpose of this document

Based on the deliverables from the previous work packages, i.e. L1 (analysis of user needs), L2 (Requirements analysis IT), L3 (Implementation specification) and L4 (Implementation), this report provides a summary of work package 5 (verification and validation)..

2 Summary of previous work in the project

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).

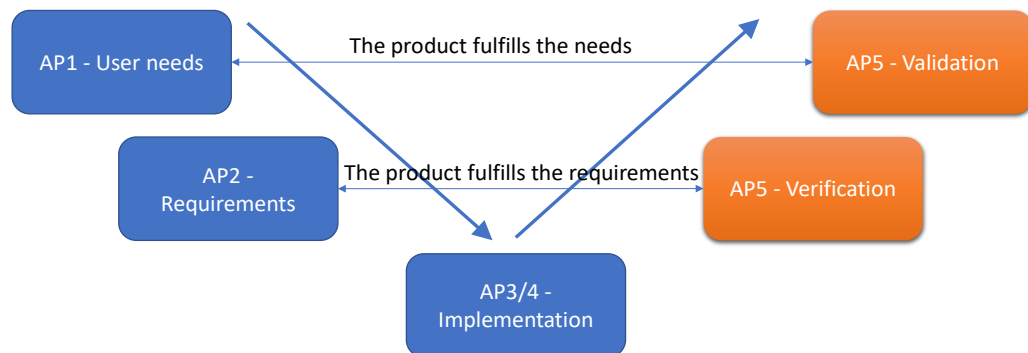
The results from this investigation have been compiled into a requirements analysis (Project Industry practices for application of CoClass in software - AP2, 2019), together with requirements from the participating software providers to capture a representative set of requirements from a large group 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.

This report summarizes the results of the verification and validation performed in work package 5 (AP5) based on the specified, implemented and tested cases.

3 Implementation specification

3.1 Principles and organization

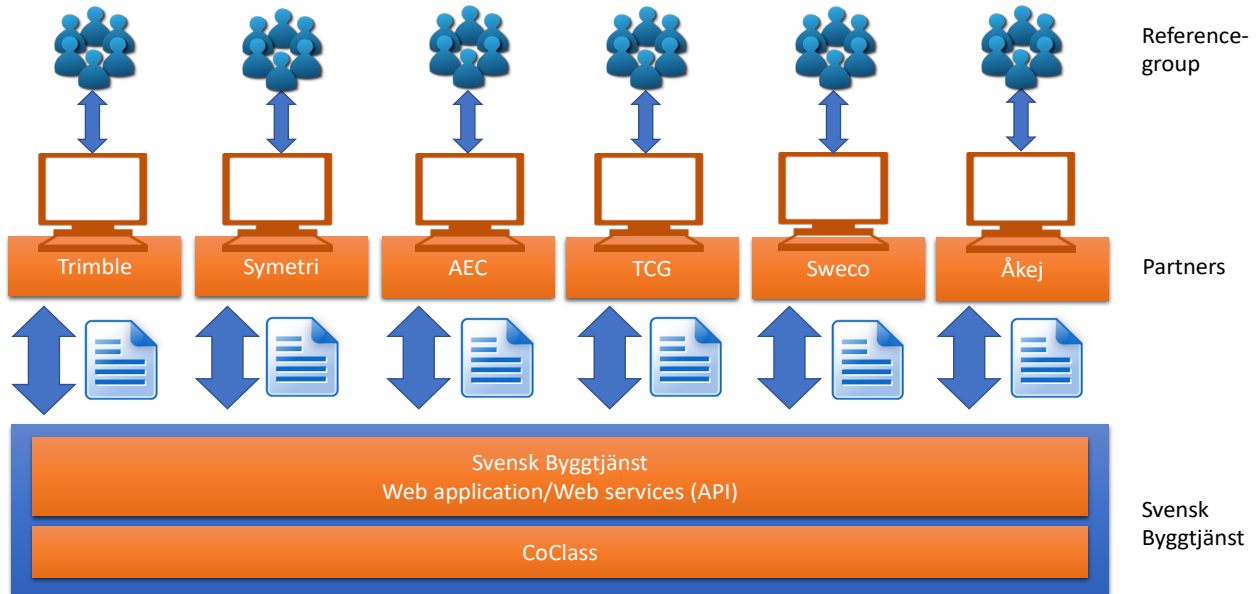
Based on the requirements analysis, the implementation specification and the actual implementation, AP5 verifies and validates the implemented solutions.



The implementations are made in the respective software package provided by the project partners and shall cover important needs from their users regarding the use of CoClass.

The figure below gives an overview of the organization of the work:

- Each partner has some software supporting certain categories of users
- The software makes use of CoClass and the related web services
- Each partner creates an implementation specification for one or more selected test scenarios
- Each test scenario is described by detailed steps including input, processing, output, requirements mapping and a method for verification and validation
- The test scenarios are implemented and verified by the partners
- Each partner validates their solution together with representatives from the reference group (same representatives as in the user needs analysis)



3.2 Description of the software packages

The table below gives an overview of the software packages chosen for the implementation and their dedicated market and area of use.

Partner	Software	Software market and area of use
Trimble	Trimble Novapoint & Trimble Quadri	Trimble Novapoint & Trimble Quadri is used for civil design, construction and maintenance of infrastructure projects. Mainly used by technical consultants but also contractors, municipalities and infrastructure owners.
Symetri	Naviate BIMeye Anavitor	Construction and production.
AEC	Savoir & AEC PLUS Infra	The software can be used in all phases of the lifecycle of an infrastructure project. The software is primarily used by design engineers when working on designing a project this to deploy the right codes and also for quality checking deliverables and coding. The receiving client/asset owner can also use the software for example checking that requirements are fulfilled
TCG	Master Concept (Vendor: IDES AB)	Information and documentation engineering data hub for large property owners/ plant owners with technically more complex facilities e.g. nuclear plants, district heating plants, energy distribution, process industries, hospitals and large building complexes etc. Covering all information and documentation needed by all roles in the business processes from customer inquiries to maintenance and overhaul. Fully IEC/ISO 813 46-1, -2, -10 (KKS) and -12 (CoClass) compliant including multiple aspects, version handling, item and cost aggregation at any level in the hierarchy
Sweco Position (Safe Software)	FME Desktop 2019 & FME Server 2019	FME is an ETL-tool (extract, transform, load) and is widely used in the following industries: Airports & Aviation, Architecture, Engineering and Construction, Commercial, Defense and Aerospace, Emergency Services, Energy, Federal Government, Health Care, Local Government, Natural Resources, State Government, Telecommunications, Transportation and Utilities. FME can be, and is used, in all parts of the life cycle for data management, data validation, data extraction, data transformation and data load. The software can read and write over 400 different data formats/sources.
Åkej	Software using fi2xml classlist functionality	This is to transfer classification information to final storage in FM software
Svensk Byggtjänst	coclass.byggtjanst.se , including CoClass Studio web application and CoClass API	CoClass is the Swedish classification system for all built environments. The purpose of CoClass is that the model should be used by all parties throughout the construction work's life cycle - from the early stages to management and demolition. With CoClass, all parties have access to a common language with the same concepts and terminology

in all software and in all information deliveries. CoClass is a digital language that can be read by both man and machine.

3.3 Description of the test cases

The table below gives an overview of the test cases specified by the project partners.

Partner	Chosen scenario	Purpose/benefit of chosen scenario
Trimble	Road Owner Nye Veier adopt CoClass for classification of assets	Nye Veier is a new CoClass customer that are eager to test out CoClass for classification of their assets
Symetri	Transfer information from requirements to construction and production where the result can be verified and stored in FM.	The purpose is to make the information and their properties to the classified through the whole lifecycle. E.g. That you could verify the same component through the whole lifecycle. It shall be possible to verify objects and its properties at the different delivery milestones to make sure that a complete classification has been done at the last delivery.
AEC	The Designer is working on design of an infrastructure project. The Designer have requirements to use CoClass. The designer needs to have all relevant CoClass codes for his discipline that are relevant for his project. The Designer access the codes and picks some relevant codes. When delivery to the client is to be done the Designer can check that the objects have the relevant coding. When Byggtjänst updates the CoClass to a new version the designer needs to update the project to that version. The designer needs to understand how the changes will be relevant and impact his project	Using, quality checking and selecting, defining, updating and validating CoClass codes within a project.
TCG	The test scenario was a new bridge incl the road up to a bridge and lightning along the road and on the bridge. The old bridge was dismantled. Thus achieving a continuous flow of information from planning to dismantling. An IFC model from Trafikverket was imported. Properties, documents and item specific software were linked to objects and articles. A preventive maintenance order was added. Resources, number of articles	A typical scenario for any contractor, property or infrastructure owner. The information model based on the Trafikverket standard, IEC 813 46-1, -2, 12 and Coclass naming standard. Implementing two aspects of the bridge, a constructive system (the bridge) and a functional system (the power network).

	and costs was added per object and aggregated upwards.	
Sweco Position (Safe Software)	Semi-automatically set CoClass codes for objects in Revit files and tabular data format. The user can upload a Revit file or a file in a tabular format with objects that doesn't have any CoClass codes set. FME will read and interpret the information about the objects, make requests to the CoClass API, retrieve and transform the results and present it to the user for further handling.	
Åkej	When fi2xml software requires classlist verification CoClass API simulates and fi2 classlists so that these software can verify they do with other classes.	The purpose is to make the information and their properties to the classified through the whole lifecycle. E.g. That you could verify the same component through the whole lifecycle. It shall be possible to verify objects and its properties at the different delivery milestones to make sure that a complete classification has been done at the last delivery.
Svensk Byggtjänst	A developer creates a structure in CoClass Studio for use in future work in planning a construction. The developer shares the structure with one or more people in order for them to continue work. Alt 1: The persons that the structure is shared to downloads it and imports it in another tool to continue work. Alt 2: The persons that the structure is shared to uses another tool and imports the structure through the CoClass API to continue work.	Enables a developer to create a structure and share it to other people that needs to work with it. Enables one common data source for all to work with

General tests of Svensk Byggtjänst's CoClass API concerning non-functional requirements such as authentication/authorization, requests and replies, error responses, documentation will be conducted by those project partners that will use the CoClass-API.

3.4 Complete list of test cases including verification of requirements

All partners have conducted a list of test cases including verification of each test case. A test case can either pass or fail. See link to each test case in column *Link to test cases* for results. The ID of a test-case is constructed according to the syntax *P-Pn-m* where P

is Partner ID, n is test case ID and m is serial number, for example 1-P0-01. The following list shows Partner ID.

Id	Name
0	Svensk Byggtjänst
1	Trimble
2	Symetri/Åkej
3	AEC
4	TCG
5	Sweco Position

The following table summarizes which test cases that belong to each project partner and which requirements that will be tested. There are no reported test-cases that failed. A test-case might not be verified for various reasons and they are presented in the column *Non-verified requirements*.

Partner	ID:s of test cases	Verified requirements	Non-verified requirements	Link to test cases
Trimble	P1-01 to P2-09	F1, F2, F33	F21, F10, F22, F32, F39, F43, F55-1, F55-2, F68, F70, F72	See file: <i>Part bilagor\Part 1 - Trimble\Trimble Verification & Validation.xlsx</i>
Symetri/Åkej	P6-01/P4-01 to P6-04/P2-04	F24, F54, IF24		See folder: <i>Part bilagor\Part 2 - Symetri\</i>
AEC	3-P1-01 to 3-P3-3	F21, F28-1, F28-2, F82, F17, IF10, IF16, IF18, IF20, IF27, IF29, IF35, IF37		See file: <i>Part bilagor\Part 3 - AEC\AEC testfall CoClass implementation.xlsx</i>
TCG	P4-01 to P4-19	F1, F2, F3, F20, F22, F23, F26, F28, F32, F33, F39, F43, F44, F45, F46, F47, F49, F53, F55, F58, F62, F68, F72, F74, F76, F78, F79, F83, F84, F85, F86, F88, F89, F90, F91, F95, F96, IF1, IF8, IF9, IF10, IF11, IF16, IF18, IF20, IF32, IF33, IF35 F25	F50, F73, F92, F94	See file: <i>Part bilagor\Part 4 - TCG\Draft 04b Testfall TCG Bro Kravspec.xlsx</i>
Sweco Position (Safe Software)	5-P5-01 to 5-P5-02	F18, F19, IF21		See file: <i>Part bilagor\Part 5 - Sweco Position\Sweco Position testfall fr AP3.xlsx</i>

Svensk Byggtjänst	P0-01 to P0-03	F1, F2, F12, F98, F99, IF37	Not included in this work package	Not included in this work package
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3.5 Test cases and lifecycle

The table below gives an overview on how the verified test cases map to the different stages in the lifecycle of built assets.

Life cycle stage	Trimble	Symetri/Åkej	AEC	TCG	Sweco	Sv. Byggtj.
Planning		x	x	x	x	x
Design	x	x	x	x	x	
Construction		x	x	x		
Maintenance	x	x		x		
Operations	x	x		x		
Demolition		x		x		

3.6 Validation

The validation was performed by analyzing how the test cases are connected to the user needs and running the test cases together with the reference group representatives. The following table summarizes the validated user needs for each part.

Partner	Reference group representative	ID:s of test cases	Validated user needs
Trimble	No representative	1-P1-01 to 1-P1-09	Trimble has referenced to user needs from Nye Veier and not from user needs in PL1.
Symetri/Åkej		P6-01/P4-01 to P6-04/P2-04	
AEC	Johan Asplund, Sweco Civil AB	3-P1-01 to 3-P3-3	User need in chapters: 2.3.1 bullet 1,6,8 2.3.3 bullet 1,5 2.3.4 bullet 4
TCG	Mikael Törnkvist, Trafikverket	P4-01 to P4-19	TCG has referenced to user needs from Trafikverket and not from user needs in PL1.
Sweco Position (Safe Software)	No representative	5-P5-01 to 5-P5-02	User needs in Chapter 2. See requirements F18, F19, IF21

Svensk Byggtjänst	Not included in this work package	P0-01 to P0-03	Not included in this work package
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The reference group representatives have been given the opportunity to reflect and report on their expressed needs. See following table for comments.

Partner	Reference group representative	Reference group comments
Trimble	No representative	Good that you start from an application structure in CoClass studio. However, whether CoClass Studio idea will help the industry forward is a question for another forum.
Symetri/Åkej		<p>The reference string is possibly a solution, but for the future we hope that the focus is not on the string but that we get support for object-based management. Where different tables can be managed on different parameters. The format sent should be for example json where each table has its own tag with content and version number.</p> <p>Would be exciting to see if it is possible to handle different versions of CoClass with a string-oriented mind frame and if it is possible to keep the string updated over its life cycle.</p>
AEC	Johan Asplund, Sweco Civil AB	If you are just looking to classify the objects, the solution works well. But what about properties and property values?
TCG	Mikael Törnkvist, Trafikverket	The software already manages reference designations and not surprisingly also reference

		designations based on CoClass. Nice with the verification of requirements. This requires that the industry manages to specify that type of requirement.
Sweco Position (Safe Software)	No representative	Positive with a solution that utilizes CoClass so that it becomes manageable for the person to classify.
Svensk Byggtjänst	Not included in this work package	

3.7 Analysis/Summary

The scenarios and test cases from each project part has been chosen by respective project part to match their existing and/or prospective customer needs. The goal hasn't been to coordinate these scenarios. Symetri and Åkej has chosen to work together and therefore will aim to cover all the different stages in the lifecycle of built assets.

A short timeframe and a late release of the API from Svensk Byggtjänst have limited the scope of the POC for each part. The test-cases can still present a verification of several important user needs, for example the possibility to search and query CoClass. The test-cases verifies a range of functional requirements, from usability to interoperability.

For many parts, the focus has been on classification and storing the classes and their hierarchical relationships in a reference string. The test-cases verifies that there are solutions for classification based on CoClass that can be used and implemented. However, the reference group notes that a reference string may not be the best solution in the future. There are other data formats that may replace or complement the reference string, for example JSON. Also, using CoClass in the context of data exchange based on e.g. IFC (<https://www.iso.org/standard/70303.html>) or other existing similar standards may affect the way in which CoClass is referenced or used. Therefore, a recommendation for the future could be to clearly separate between the conceptual content of CoClass and the way it is being represented in different situations such as file-based data exchange, internet-based messaging, as linked data (https://en.wikipedia.org/wiki/Linked_data) or as data stored in a project- or asset information database system.

The management of different CoClass versions may be critical for the software suppliers to enable stable implementations that work over time when CoClass content is updated. The level of criticality is best judged by the software suppliers. Therefore, further studies need to be conducted for testing how different versions of CoClass codes shall be handled.

Finally, it can be concluded that many of the groups who were involved in expressing their needs have not been involved in validating the solutions. The reference group had limited time to validate the solutions. This is something that the further work with the Industry practice will address.

4 Normative references

- (2019). *IEC FDIS 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*.



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