Change toolkit for digital building permit

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1. Executive Summary

Crucial challenges stand out as major barriers to effective comprehensive implementation of DBPs, lack of specialisation being one of the main. To address this challenge, the CHEK project has a work package (WP5 - Upskilling/Reskilling construction value chain) that includes tasks to fill the knowledge gaps and up/re-skill the construction value chain, also including municipal officers, which is aligned with the European Recommendation (EU) 2017/1805 on the professionalisation of public procurement.

This deliverable presents the design, development and execution of the course “Digital Transformation In Building Permits: Advanced GeoBIM practices and the CHEK framework”, in the scope of Task 5.3 of the WP5. This course aims to be a course of high-level background complementary to the Massive online courses also developed within WP5 and presented in D5.2. The course was tested within a PhD summer school, with one week of intensive classes, having the equivalent workload of 3 ECTS. It comprises 10 modules on the main topics related to Digital Building Permits and on the outputs of the CHEK project. The development of the course and the materials was carried out with the collaboration of several partners, who also formed the teaching staff of the course.

Finally, this document also includes the materials developed for the course, which comprise several presentations and complementary content that were made openly available online, so it can be reused for the development of other upskill and reskill activities related to the topic.

2. Introduction

Building permits are one of the tools that a state has to guarantee the quality of the built environment against several criteria, such as safety, health, comfort and energy performance. Thus, the improvement of the process to issue a building permit is aligned with European and, in a broader sense, global efforts to tackle the climate and housing crisis. Building permits are also used to ensure compliance with architectural and urbanistic requirements, controlling the economic and social development of the urban environment while avoiding the risks of losing cultural and historical aspects of the urban landscape.

Despite its importance, the process to issue a building permit is still mostly based on manual and even sometimes paper-based procedures, lacking efficiency and transparency, consequently leading to transversal problems in construction, such as long times for a building plan to be approved or a lack of quality control in the issuance of the permits. Therefore, the past decades staged several attempts to incorporate technical advancements in the digitalisation of the construction sector, such as Building Information Modelling (BIM), as well as the advancements in the Geographic Information System (GIS) sphere to improve the automation and technological level of the activities within the building permit process, ultimately promoting a Digital Building Permit (DBP). These attempts were also followed by an increasing number of research initiatives to promote better and efficient ways to implement a DBP.

With the increased number of implementations attempts and research efforts, crucial challenges stand out as major barriers to effective, comprehensive implementation of DBPs. Lack of specialisation of the stakeholders of the building permit process is one of the main challenges, since, even with the technological advancements, the lack of the mindset and skills prevents people from knowing and understanding the need for digitalisation, as well as correctly using the tools needed to implement digital systems. Within this context, the development and dissemination of content on the importance of the Digitalisation of Building Permits and on the several technologies that need to be incorporated is mandatory for the success of the DBP efforts.

Lack of digital and inclusive knowledge and skills is one of the main barriers to the adoption of digital building permit processes, as identified in [1] and in [2], which shows the digitalisation of the mindset of the public officers as one of the ambitions of the European Network for Digital Building Permits (EUnet4DBP). The foundations of the CHEK project are built on the understanding that effective Upskill/reskill activities are needed not only towards public officers, but to all stakeholders of the building permit value chain. To tackle this challenge, the project contains a whole Work package (WP5 - Upskilling/Reskilling construction value chain) devoted to the execution of activities to disseminate knowledge for different target audiences and on different levels.

The CHEK project has worked to address skill gaps in the construction industry, including those of municipal officers, by developing a training program. This effort is part of Work Package 5 (WP5), focused on upskilling and reskilling the construction value chain. This initiative aligns with the European Recommendation (EU) 2017/1805 on the professionalisation of public procurement. A key objective of WP5 is to meet the need to “Set a training course equivalent to 3-5 ECTS credits on the DBP, comprehensively covering the theoretical background and the developed CHEK (methodological and technological) toolkit, including, from a technical-scientific point of view, allowing higher-level and massive upskilling of the future AECO value chain actors.”

To achieve this, Task 5.3 in the project's Description of Action (DoA) is to “Develop a 3 to 5 ECTS course about higher-level background, methods and tools developed by CHEK. Min. 1 edition of the course will be delivered within the duration of CHEK in open online setting, to allow maximal participation also of stakeholders external to the consortium. The platform will be Moodle, and the concept with be tailored as a Summer school, with a relatively intense program (such as 2-3 concentrated modules).”

This document presents the work on the design and development of a technical-scientific course, and shows how it fulfils the objective of WP5, and aims to address in greater depth all the technical aspects involved in the DBPs in correlation with the CHEK project's developments, such as the software tools. Section 3 demonstrates the design and development of the course structure and its specific modules. Section 4 presents the materials developed and used in the course, that can be reused in future upskill and reskill activities. Section 5 demonstrates the usage of a Moodle-based platform (CHEK e-learning) for exchange of content during the course. Section 6 presents the decisions related to the venue and logistics of the course. Section 7 demonstrates the dissemination and registration activities, while Section 8 presents the execution and feedback of the course. Finally, section 9 presents the conclusion of this work.

Additionally, Annexe III contains all the presentations developed for the course. The remaining material used in the course is publicly available online in https://doi.org/10.5281/zenodo.17035062, while. Annexe IV present the questionnaire of the course.

3. Design and development of the course

The WP5 required a high degree of collaboration within the project. This can be noticed by the involvement of all the consortium within all the tasks. This makes sense from the multidisciplinary standpoint that is involved in the development and dissemination of the plethora of topics within DBPs. With that said, the design, development and execution of the technical-scientific course involved the collaboration of several different partners for the content and to validate its quality.

Design and development of the course followed the objectives of WP5 and its tasks, as presented in Section 1. Thus, defining the structure of the course involved first setting its main knowledge objectives and how they would be distributed within the main duration of the course. The CHEK project has a comprehensive scope that reflects the current research and knowledge of DBPs and their underlying knowledge areas. The European Network for Digital Building Permits (EUnet4DBP)[1] ambitions, as well as the comprehensive state of the art present in [1], served as the main high-level references for the elaboration of the DoA and, therefore, were also used as the main reference for the knowledge objectives that should be present in the course, which can be seen in Table 1.

The alignment of the topics with the project work packages also potentialized the introduction, within each topic, of practical project outcomes, helping demonstrate concrete, focused applications of the knowledge for the building permits. As an example, topics on BIM and GIS have practical instances of implementation for building permits in the project: D2.5 - Exchange Information Requirements for DBP,[2] as well as D2.3 - CHEK CityGML specification[3], demonstrate how the information is being managed within BIM and GIS.

Table 1 – Main raised topics for the course.

Topic	Description
Understand Digital Building Permits	Explore the evolution, current state, and standards (e.g., ISO 19560) driving the digital transformation of building permits.
Technical Tools	BIM interoperability, GIS, CityGML, and the Digital City Register for managing spatial and urban data.
Analysis of Legal Frameworks	Understanding and interpretation of building permit laws and regulations in the context of digital workflows.
Law and Technology Integration	How legal principles and digital technologies converge to enable automated digital building permit processes.
CHEK project and its tools	The overview of the project, as well as the CHEK toolkit.

The course was developed to be implemented with a 1-week intensive in-person version with a derived online version. By making the in-person version, much more profound interaction was possible amongst the stakeholders, reaching inherent benefits. Additionally, the online version provides a further reach, enabling students worldwide to benefit from the contents created, extending the impact of the course. 10 modules were defined to be split between each of the high-level topics. The combination of both “in-person” course and the derived online version are fully satisfying the objectives set out in the Declaration of Action towards an advanced course with open online setting.

[1] https://eu4dbp.net/#about
[2] https://chekdbp.eu/wp-content/uploads/2024/11/D2.5_Exchange_Information_Requirements_for_DBP_v1.0_Final.pdf
[3] https://chekdbp.eu/wp-content/uploads/2024/04/D2.3_CHEK_101058559_CityGML-specification_v1.0_FINAL_.pdf

The European Credit Transfer and Accumulation System (ECTS) is a metric to promote transparency within courses and studies. One ECTS credit is equivalent to 25 to 30 hours of work, including classes and autonomous work. The course comprises 30 hours of classes (5 days x 6 hours of classes), but the work to completely explore the main and complementary material can lead to an additional 45 hours of autonomous work. The total workload for this course can be considered of 75 hours. In this way and considering one ECTS credit as having a workload of 25 hours, the course is considered equivalent to 3 ECTS (3 x 25h = 75h). This duration fulfils the DoA needs, as determined in the WP5 objectives that the course must be equivalent to 3-5 ECTS.

The detailing of the modules was defined in an active collaboration between partners within the consortium. Not only that, but the elaboration and presentation of the classes were coordinated between the University partners within the project, to leverage on their expertise, promoting high-level deliveries for all the modules. Thus, specific course meetings between consortium partners took place during the project to align the design of the course and the development of materials. Also, the course was discussed in a broader form within project monthly meetings, allowing an extensive consideration of the design choices and further contributions. This careful development also needed to be intensified in the last months before the course to accommodate the results of software development and integration between the different solutions developed in the CHEK project.

To enable a further comprehension of the workflows using the developed software solutions, a process map was developed within WP5. This process map is presented in the D5.2 - Materials for different types of users and contains workflows to enable the compliance check from the perspective of the designer and the municipality. Hence, software companies agreed to create presentations guided by this map, explaining how the tools are incorporated in the permit workflow and some practical use aspects. The level of detailing of each module considered the high-level background described in the DoA; therefore, the main target audience was “Civil Engineers and Architects engaged in research (e.g., PhD students) or working at an advanced level in the industry”. Table 2 presents the main responsibilities for each module and its material.

Table 2 – Modules of the course and their responsible partners.

Module	Responsible partner
M1 – Introduction and State of the Art on Building Permits	Gaiurb and Univ. of Minho
M2 – BIM standardisation	Univ. of Minho
M3 – Interoperability, openBIM and IFC	Univ. of Minho
M4 – Interoperability beyond IFC	Univ. of Minho
M5 – 3D city modelling: background and standards	TU Delft
M6 – Creation of 3D city models and GeoBIM integration	TU Delft
M7 - Building Permits Law	Univ. of Brescia
M8 – Interpretation of Regulations: workshop	Univ. of Brescia and Fraunhofer Italia
M9 – Integration of CHEK DBP Process and Digital Technologies for DBP Automation	Fraunhofer Italia
M10 – Tools and practical examples of CHEK DBP	CYPE, Virtual City Systems, Xinaps, DiRoots

All the detailing of the content and the partner responsible for each topic is presented in the next subsections.

Module 1 - Introduction and State of the Art on Building Permits

This module introduces the CHEK project and its role in advancing digital building permit (DBP) processes. It also presents key research works on DBP, offering insights into current challenges and innovations. This module has a strong collaboration of the Gaiurb partners, who organised a guided visit to their permit department, providing practical exposure to real-world workflows. Additionally, the module explores the state of the art of digital building permits, highlighting its trends and developments in several countries.

Module 2 - BIM standardisation

This module provides an overview of the standards related to the implementation of BIM. It covers ISO 7817 (Level of Information Need), ISO 23386 and ISO 23387 (Product Data Templates), and ISO 12006-2 (Classification Systems). Additionally, it explores ISO 19560, detailing concepts, principles, and processes for managing information throughout the asset lifecycle, from requirements definition to the delivery phase.

Module 3 - Interoperability, openBIM and IFC

This module introduces advanced topics on interoperability, focusing on the role of OpenBIM and buildingSMART in enabling seamless data exchange through the development of open formats. It covers different types of BIM tools, the importance of interoperability, and the principles of OpenBIM. A deep dive into IFC (Industry Foundation Classes) explores its history, schema, file structure, and key elements. Practical aspects include georeferencing in IFC, coordinate reference systems, and techniques for analysing IFC files using viewers and text editors.

Module 4 - Interoperability beyond IFC

This module provides a structured understanding of information exchange in BIM, focusing on Model View Definitions (MVD), Information Delivery Specifications (IDS), the buildingSMART Data Dictionary (bsDD), and the BIM Collaboration Format (BCF). It explores how these concepts facilitate interoperability and structured data exchange. Practical insights include defining IDS, exploring bsDD, using BCF for communication, and managing information in a CDE.

Module 5 - 3D city modelling: background and standard

The module aims to explain how cities are modelled in 3D. The first part of the module contains an overview of the relevant background concepts and methods, mainly covering topics from 2D and 3D GIS, such as the representation of geometry, topology and semantics, georeferencing and projections, and a sample of processing techniques and software. The second part of the module provides a technical overview of 3D city modelling, including concepts such as semantic surfaces and templates, and, concretely, how different classes of objects are modelled according to the standards that are used for it.

Module 6 - Creation of 3D city models and GeoBIM integration

The module explains how 3D city models can be created and processed, as well as how they can be integrated with BIM models. The first part of the module covers some methodologies that can be used to jointly process and merge different typical 2D datasets to create a 3D city model, including a demonstration of the open source software 3dfier (https://tudelft3d.github.io/3dfier/) using 2D topographic data and a point cloud. The second part discusses the theoretical and practical aspects behind GIS and BIM integration (GeoBIM), including relevant concepts from integration and interoperability, as well as the conversion from Geo to BIM and vice versa.

Module 7 - Building Permits Law

The aim of the module is to have an overview of Public Administration processes and to know a methodology for interpreting regulatory regulations. It focuses on legal reflections on the issue of automation of decision-making processes of the Public Administration in the European legal framework. It also provides an in-depth look at the use of building information modelling and artificial intelligence. A manual methodology for analysing regulations and identifying information requirements is proposed. Using labelling, objects and properties are defined, then standardised according to widely used BIM and GIS standards.

Module 8 - Interpretation of Regulations: workshop

The workshop aims to teach a methodology for analysing regulations to define information requirements and verification logic. Participants are prompted to identify elements required in building and city models and apply a labelling approach to structure data from regulations in tabular form. The session also introduces OpenAI tools, covering GPT customisation, prompt design, and automating regulation analysis. Through hands-on exercises and demonstrations, attendees test AI performance, reflect on challenges, and explore next steps, gaining skills to apply AI-driven solutions in regulatory contexts.

Module 9 - Integration of CHEK DBP Process and Digital Technologies for DBP Automation

This advanced module explores the CHEK project's integration of process mapping and digital tools to transform building permit workflows. Participants analyse "as-is" processes through municipal workshops, identifying inefficiencies and bottlenecks, then design optimised "to-be" systems with BIM/GIS interoperability, automated rule-checking, visual inspection platforms, and digital signatures. The project's modular digital infrastructure supports scalability, compliance, and centralised data management, guided by KPIs like transparency and efficiency. A hands-on workshop enables attendees to create tailored "to-be" process maps, applying these tools to minimise delays, reduce errors, and adapt solutions to regional regulations. Emphasising user-friendliness for municipalities and applicants, the module equips learners to drive efficient, transparent, and scalable permit systems.

Module 10 - Tools and practical examples of CHEK DB

During this module, an overview of CHEK tools and workflow is provided. After this general overview, some of the tools are explained in depth. The objective of the initial overview is to look to all the tools that are relevant for de Digital Building Permit, not all these tools are explained in depth as we do not have the time to do so (IFC Checkers, CityGML Checks, IDS Exporters. The second part emphasizes three aspects: i) the DBP management platform both for designers and municipalities; ii) site and architecture models and iii) different types of checking tools that are portrayed in the project. The session has practical examples that will be accessible and provided to the students. The idea is to explain and provide access to the tools to students, but not for the students to use the tools live during the session.

4. Materials and further impact

A set of materials were developed improve the dissemination of course content and further engage the course participants during the classes. These materials included presentations, lecture and workshop guidelines, templates, datasets, building models and datasets. Other materials, such as papers and CHEK outcomes, were also used to demonstrate the state of the art and the project contributions to the students.

The development of the materials was done by the teaching staff of the course, that were able to integrate the main state of the art within DBP and its related topics, as presented in the Section 3, in these materials. The quality of the content was also guaranteed by the coordination of the task in specific course meetings and general meetings of the project.

Another critical of these materials is to extend the impact of this course by allowing its reuse by other Universities and courses. For this reason, all the content produced for this course is shared in Zenodo through this link: https://doi.org/10.5281/zenodo.17035062. The sharing of the content was carefully agreed with all its authors, that agreed to distribute it under the licence CC BY 4.0, that enable sharing and adaptation of contents provided a correct attribution of its authors.

The presentations include not only theoretical aspects of the topics but also examples and practical sessions (Figure 1), that can be used to increase the dynamic of the lectures and to raise discussions in the class, raising further questions and enabling a deep interaction with the students.

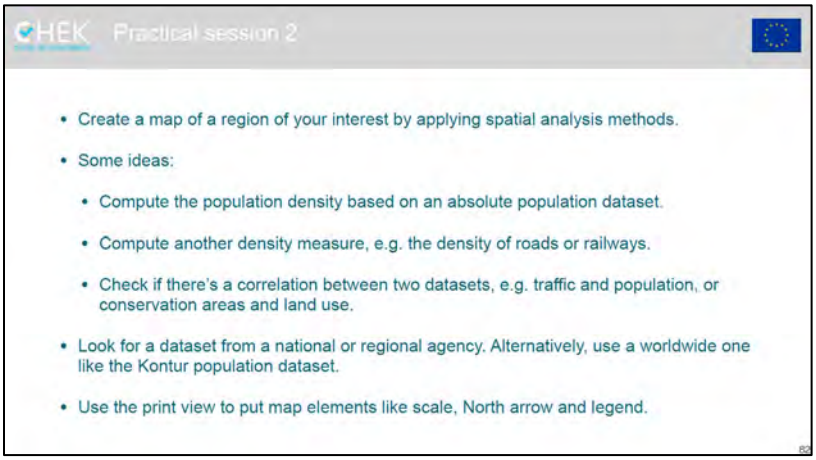


Figure 1 - Practical section in the 3D city modelling presentation.

To support the challenges, models, datasets and other documents were used. While some were adapted exclusively for the course, as the model presented in Figure 2, that was adapted from an internal test model of the University of Minho to demonstrate how an IFC model can be correctly georeferenced, other datasets were taken from public available repositories. All these support materials are either on the public open repository or are already available through permanent links. Annexe I presents the relation and description of the materials available in the link https://doi.org/10.5281/zenodo.17035062. Annexe II presents the materials, such as open datasets that were already publicly available, with the links to pages where they can be downloaded.



Figure 2 - IFC model adapted to demonstrate georeferenced.

This distribution of materials promotes an impact that extends the duration of CHEK project. Upskilling and reskilling activities will be necessary in the following years to promote the correct adoption and implementation of DBP processes around the world. The material developed for this course provides a comprehensive set of knowledge that shall be reused and adapted to enable the development of classes, lectures and entire courses.

5. Moodle platform

The development of the course was supported by the development of several materials to allow the classes to be correctly followed by the students, as well as give them high-quality content that could be reused for further upskilling and reskilling initiatives beyond the CHEK project. To allow a proper dissemination of this material, it was made through the implementation of the course into the Moodle-based CHEK e-learning platform (https://elearning.chekdbp.eu/) (Figure 3). 15 presentations were made available, containing all the content of the course, and are available in Annexe III. Besides that, the platform hosts additional complementary files, including process maps, spreadsheets, IFC files and other documents that were made available for the students. All this content is openly available online through the link: https://doi.org/10.5281/zenodo.17035062.

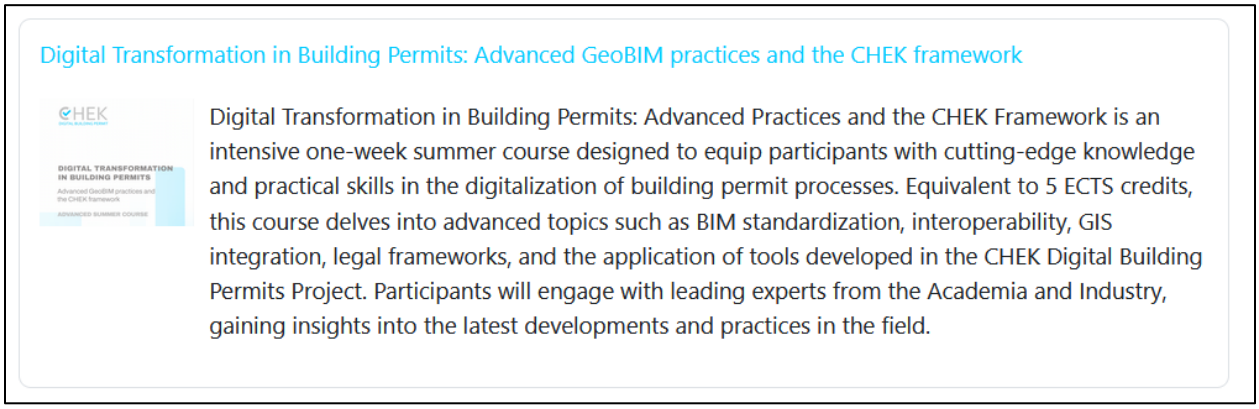


Figure 3 - Moodle access to the course.

The platform contains several features to host course content, such as attendance registration, storage of documents, videos and files, as well as questionnaires and the controlled issuance of certificates. All 10 modules of the course were implemented as sections in the platform to host the material (Figure 4).

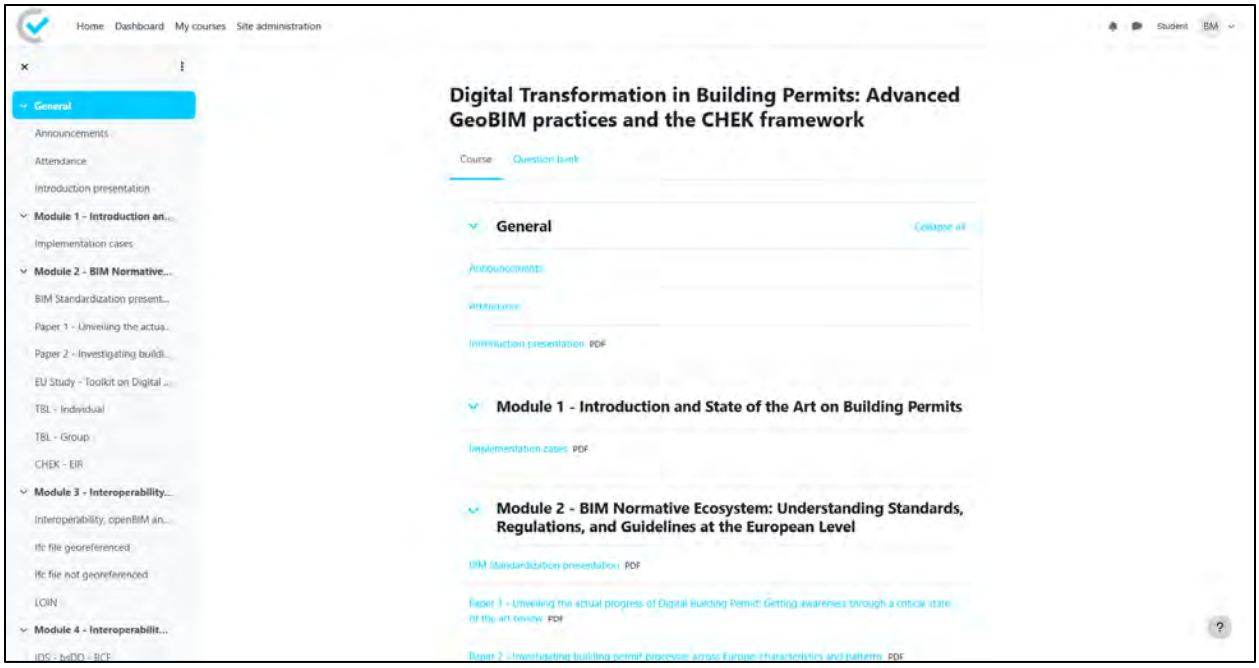


Figure 4 - Main page of the course in the CHEK e-learning platform.

Within the platform, a participation certificate was created. The certificate was programmed to be automatically issued when the student finishes the course, with a minimum of 2/3 of attendance and after the student finishes the questionnaire. It was a strategy to guarantee the commitment of the students and guarantee a high rate of answers to the questionnaire. As seen in Figures 5 and 6, the certificate consists of 2 pages, with general information about the course. It also includes a QR code on the front page, allowing verification of the authenticity of the document.

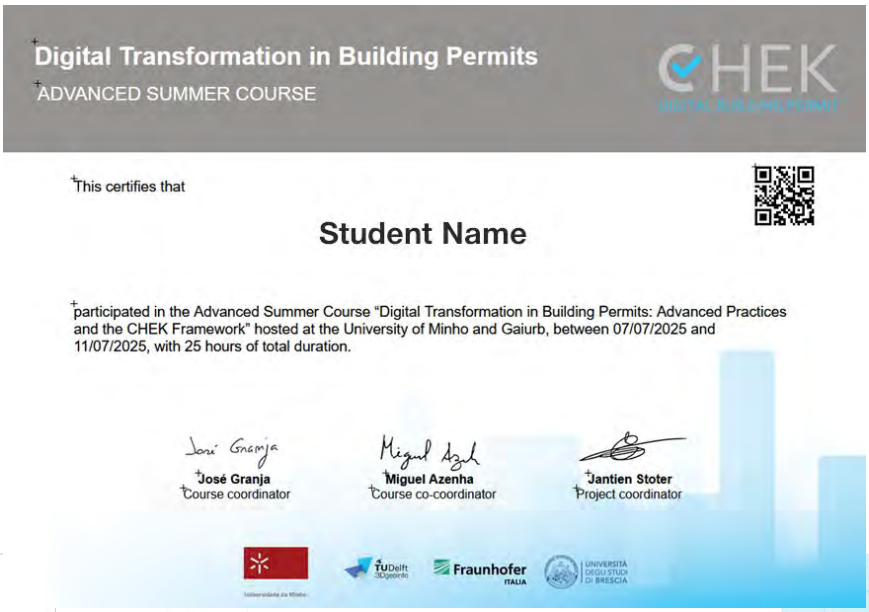
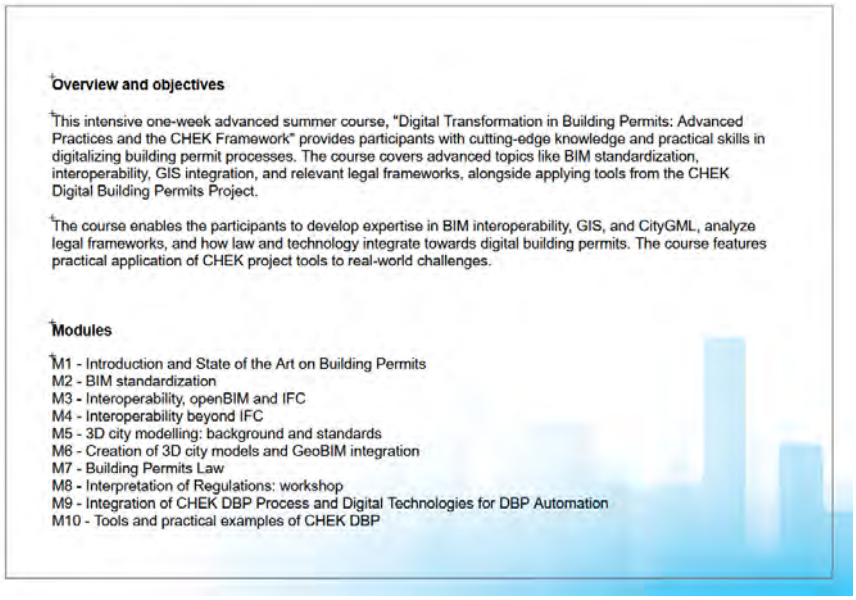


Figure 5 - Front page of the certificate.



Overview and objectives

This intensive one-week advanced summer course, "Digital Transformation in Building Permits: Advanced Practices and the CHEK Framework" provides participants with cutting-edge knowledge and practical skills in digitalizing building permit processes. The course covers advanced topics like BIM standardization, interoperability, GIS integration, and relevant legal frameworks, alongside applying tools from the CHEK Digital Building Permits Project.

The course enables the participants to develop expertise in BIM interoperability, GIS, and CityGML, analyze legal frameworks, and how law and technology integrate towards digital building permits. The course features practical application of CHEK project tools to real-world challenges.

Modules

M1 - Introduction and State of the Art on Building Permits
M2 - BIM standardization
M3 - Interoperability, openBIM and IFC
M4 - Interoperability beyond IFC
M5 - 3D city modelling: background and standards
M6 - Creation of 3D city models and GeoBIM integration
M7 - Building Permits Law
M8 - Interpretation of Regulations: workshop
M9 - Integration of CHEK DBP Process and Digital Technologies for DBP Automation
M10 - Tools and practical examples of CHEK DBP

Figure 6 - Back page of the certificate.

Another version of the course was implemented on the platform. This version is a pure online version of the course, containing the adaptation of the materials developed for the in-person version. Further reach is expected by the implementation of this other version, since it enables worldwide students to freely register and access its contents.

6. Venue and logistics

The course was set to be primarily hosted by the University of Minho, with the opening day taking place at Gaiurb. This decision was influenced by a guided tour provided by Gaiurb permit experts during the CHEK presential consortium meeting in March 2025. The tour demonstrated the municipality's step-by-step workflow for issuing a building permit. This activity successfully highlighted the hurdles and potential improvements for digitalising the process. Given that Gaiurb's facilities are in Vila Nova de Gaia, a 70-minute train journey from Guimarães, the initial day of the course was therefore conducted at their location to leverage this practical demonstration. Finally, Gaiurb's premisses can accommodate the 25 students that were planned for the course and have the correct infrastructure to enable the presentations and activities that demanded the connection of laptops.



Figure 7 - Gaiurb premisses.

The premisses in the Campus de Couros (Figure 8), in Guimarães-Portugal, were chosen as the main location, since the campus also hosts 2 European Masters, including BIM A+. The infrastructure of the campus is adequate to host this type of course, containing several screens that can be used by the students. Finally, the Couros Zone, where the campus is located, is declared as World Heritage by UNESCO and has easy access through the train station, facilitating the access of the students.

Considering the DoA, the course was set to occur from 7 to 11 of July in 2025, being tailored as a Summer Course.



Figure 8 - On the left side, the main room of the course. On the right side, the entrance of the campus.

The transport and accommodation logistics were on the responsibility of the participants. However, the locations were easily accessible by public transport. Coffee-breaks were provided all days for the participants. The lunch, besides the first day, was also provided for the students in the premisses of the University of Minho.

7. Course promotion and registration

To attend to the requirements of extensive participation outside the consortium, the dissemination of the course occurred through different platforms. A page was developed (Figure 9) on the CHEK website[4] containing information about the course and allowing registration. The dissemination also occurred through LinkedIn (Figure 10), which is the main social network of the project.



Figure 9 - Dissemination of the Advanced Summer Course on the CHEK website.



Figure 10 - Dissemination of the Advanced Summer Course on CHEK social media.

[4] https://chekdbp.eu/asc/

A form was created to enable enrolment of the students in the course (Figure 11). It comprised a series of mandatory information to not only identify the students but also to evaluate their skills against the minimum requirements defined, i.e. BSc degree in Architecture or Civil Engineering or equivalent. Despite the course being free of charge, the success of registration was conditional on an initial deposit of 150 €, reimbursed upon attendance. This initial deposit was demanded to guarantee a commitment of the enrolled students, avoiding the risks of low attendance.

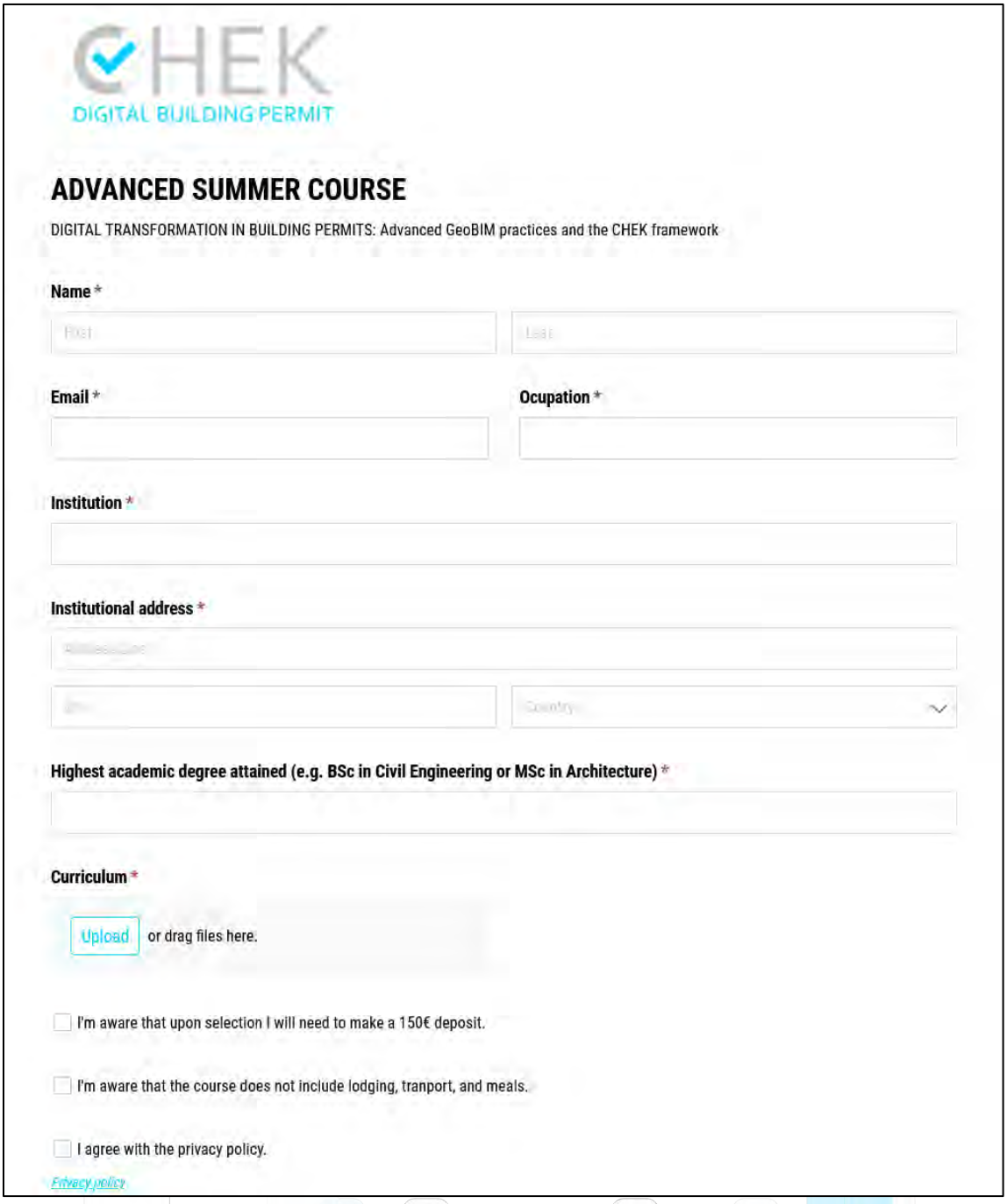


Figure 11 - Registration form.

25 participants were enrolled, with 15 different countries being represented by the nationalities and institutions (Figure 12). This demonstrates the extensive dissemination provided by the course.



Figure 12 - Countries represented in the course: Portugal, Afghanistan, Iran, India, Brazil, Kazakhstan, Ghana, Pakistan, Ecuador, Russia, Saudi Arabia, Spain, United Kingdom, Germany, Italy.

8. Execution and feedback

The course occurred according to the schedule demonstrated in Table 3. The 25 enrolled students who confirmed their presence were able to be present at the course. As shown in Figure 12 , students came from different countries worldwide with Architecture and Civil Engineering backgrounds, improving the discussions with their different perspectives and experiences with local building permit practices.

Table 3 – Course schedule and venues.

Day	Module	Venue
07/07	M1 – Introduction and State of the Art on Building Permits M2 – BIM standardisation	GAIURB
08/07	M3 – Interoperability, openBIM and IFC M4 – Interoperability beyond IFC	Univ. of Minho
09/07	M5 – 3D city modelling: background and standards M6 – Creation of 3D city models and GeoBIM integration	Univ. of Minho
10/07	M7 - Building Permits Law M8 – Interpretation of Regulations: workshop	Univ. of Minho
11/07	M9 – Integration of CHEK DBP Process and Digital Technologies for DBP Automation M10 – Tools and practical examples of CHEK DBP	Univ. of Minho

The practice-theoretical approach was well received by the students (Figure 13). They engaged in all activities within Project-Based Learning, workshops and assignments, which also demonstrated a deeper understanding and application of the concepts. This was evident in their ability to collaborate effectively, solve complex problems, and produce high-quality work that reflected a strong grasp of the subject matter.



Figure 13 - Project-Based Learning on the first day of the course.

The guided tour in Gaiurb, demonstrated in Figure 14, in the first day of the course, enabled the participants to better understand the challenges and improvement potential with concrete examples.



Figure 14 - Guided tour at Gaiurb.

The subsequent days were filled with the classes comprising theoretical and practical activities, finishing with the demonstration of the CHEK tools by present and online professionals (Figure 15) from the software houses.



Figure 15 - CYPE presentation in the last day of the course.

A questionnaire was provided (Annexe IV) to gather feedback from students. It consisted of 11 questions, being 10 asking the students to evaluate in a 0-10 scale their satisfaction with one of each module and 1 open question asking if they believe that the CHEK toolkit offers solutions to the issues faced in implementing DBPs, also asking them to provide additional comments about the course and the project.

Regarding the answers to the open question (Figure 16), the overall opinion agrees that the CHEK toolkit is valuable and the project is relevant. The practical and flexible foundation of the toolkit was also considered promising in the objective to tackle the DBP challenges. On the course, the opinions were positive, with some comments on how the practical component of the modules was considered ideal to balance with the density of the high-level background.

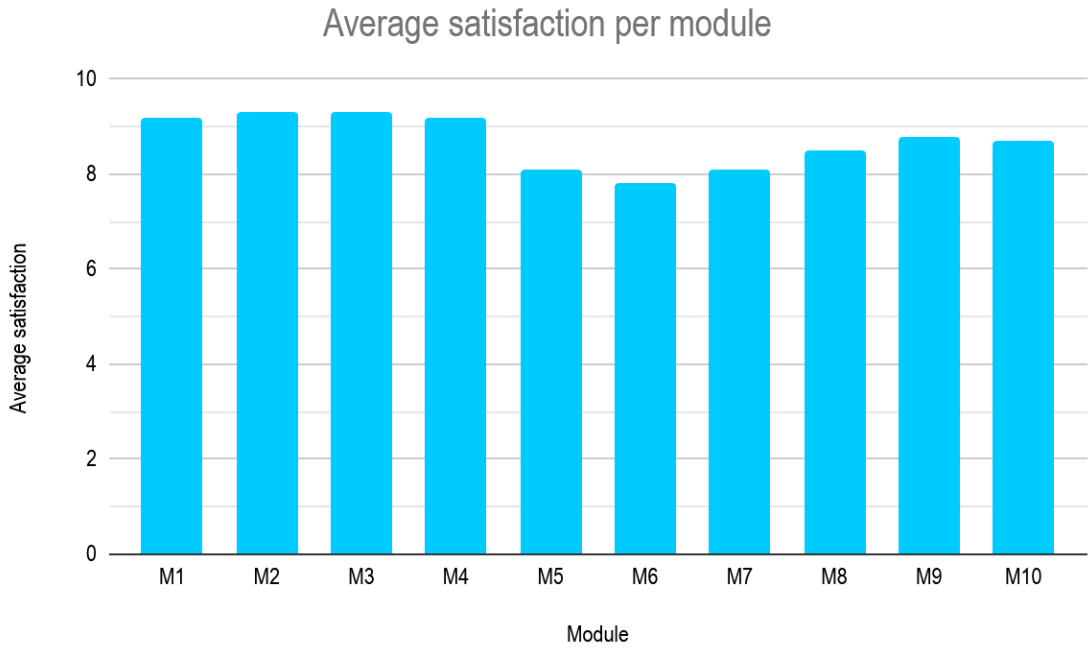


Figure 16 - Average satisfaction per module.

Figure 17 presents the students with the UMinho CHEK team and part of the Fraunhofer CHEK team.



Figure 17 - Final photo with participants and members of the CHEK project.

At the end of the course, the certificate was issued, considering the requirements described in Section 5. From the 25 participants, 23 were able to obtain the certificate, showing a good commitment to the course.

9. Conclusion

The need for upskilling/reskilling of professionals in the construction value chain is critical for a successful implementation of the DBP process. CHEK is promoting several tasks within its WP5 to capacitate professionals at different skill levels. One of these tasks is the 5.3, which consists of a technical-scientific course of high-level background, tools and methods developed by CHEK. The developed course materials are to be made available for future use by others.

This deliverable presented the design and development of the technical-scientific course, denominated “Digital Transformation In Building Permits: Advanced GeoBIM practices and the CHEK framework”. It consisted of 10 modules covering a comprehensive set of topics that are needed to understand the underlying knowledge necessary to implement the DBP process, as well as how it connects to the tools and methods developed by the project. The course had a week's duration (equivalent to 3 ECTS) and was coordinated by the University in cooperation with partners of the consortium.

The course was conducted in Portugal, initiated on the premises of Gaiurb and subsequently transitioning to the Historical Centre of Guimarães, which encompasses a campus of the university. The course integrated theoretical lectures with practical and supervised assignments to foster an engaging experience for the students. Furthermore, a collection of materials was provided to the students via the Moodle-based CHEK e-learning platform.

At the end of the course, the students evaluated the course via a questionnaire. The overall experience was highly positive, with an average classification of the modules of 8.7/10. The students also had positive opinions on the presented CHEK toolkit, feeling that it set good foundations for the implementation of DBP processes.

Additionally, to the in-person version of the course, a pure online version was implemented, to enable an extensive reach of the course and extend its impact. This online version is available in elearning.chekdbp.eu under free registration for any interested party.

The materials developed also configure an important contribution of the CHEK project. By gathering state of the art knowledge and being openly accessible for sharing and adaptation, other initiatives can use these materials as a foundation for the development of other upskilling and reskilling activities beyond the project.

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List of used abbreviations

DoA	-	Description of the Action
WP	-	Work Package
BIM	-	Building Information Modelling
GIS	-	Geographic Information System
DBP	-	Digital Building Permit

Annexe I – Advanced course materials

The contents of this annexe are openly available for download (CC BY 4.0) at: https://doi.org/10.5281/zenodo.17035062

Folder	File Type	File Name	Description
General	Presentation	CourseIntroduction.pdf	Presentation that introduces the course and the CHEK project.
Module 1 - Introduction and State of the Art on Building Permits	Presentation	ImplementationCases.pdf	Presentation about the state of the art for DBP implementations, discussing the used strategies, challenges and limitations.
Module 2 - BIM Normative Ecosystem	Presentation	BIMStandardization.pdf	Presentation on the BIM normative framework.
	Presentation	CHEKEIR.pdf	Presentation about the Exchange Information Requirements according to the ISO 19650 series, the example of the Portuguese EIR and the CHEK EIR.
Module 3 - Interoperability, openBIM and IFC	Model	GeoreferencedModelExample.ifc	IFC model used to exemplify the correct georeferencing procedure on an IFC 4 model.
	Model	NotGeoreferencedModelExample.ifc	IFC model without georeferencing to be used in comparison to the georeferenced model.
	Presentation	InteroperabilityOpenBIMAndIFC.pdf	Presentation on Interoperability, buildingSMART and openBIM and the IFC data model and file format.
Module 4 - Interoperability beyond IFC	Presentation	IDSbSDDBCF.pdf	Presentation on the Information Delivery Specifications (IDS), buildingSMART Data Dictionaries (bSDD) and BIM Collaboration Format (BCF).

Module 5 - 3D city modelling	Presentation	3DCityModelling.pdf	Presentation on the foundations of Geographic Information Systems (GIS) and 3D City models and its standards.
Module 6 - Creation of 3D city models	Presentation	CreationOf3DCityModelsAndGeoBIMIntegration.pdf	Presentation on the creation and processing of 3D city models and on GeoBIM integration.
Module 7 - Building Permits Law	Presentation	InterpretationOfNormativeArticle.pdf	Presentation on building regulations and its interpretation, as well as the mapping to building models and derived information requirements.
Module 8 - Interpretation of Regulations	Presentation	AiAgentForBuildingPermitInterpretation.pdf	Workshop presentation on the use of AI agents to promote interpretations of building regulations.
	Workshop guidelines	NormativeArticlesWorkshop.pdf	Excerpts of legal documents used in the workshop.
	Workshop tables template	TemplateForWorkshop.xlsx	Spreadsheet template to execute the interpretation of legal documents.
Module 9 - Integration of CHEK DBP	Presentation	IntegrationOfChekDbpProcess.pdf	Presentation on the integration of digital technologies into the building permit process.
Module 10 - Tools and practical examples	Presentation	VCMapCHEKPlugin.pdf	Presentation on the VC Map CHEK Plugin.
	Process map	CHEKProcessDesigner.pdf	Process map developed to demonstrate the integration of the several tools developed within CHEK to execute the permit process from the point of views of the designer.
	Process map	CHEKProcessMunicipality.pdf	Process map developed to demonstrate the integration of the several tools developed within CHEK to execute the permit process from the point of views of the Municipality.
	Presentation	CHEKTechnologyArchitecture.pdf	Presentation of the integration promoted by the BIMserver.center.

	Presentation	IFCExporterAndSignature.pdf	Presentation of the IFC exporter and signature tools developed by DiRoots
	Presentation	CHEKProcessMapPresentation.pdf	Presentation on the process maps developed to demonstrate the integration of tools.

Annexe II – Publicly available materials

Module	File Type	Material Name	Link
Module 2 - BIM Normative Ecosystem	Paper	Unveiling the actual progress of Digital Building Permit: Getting awareness through a critical state of the art review	Link
	Guide	Toolkit on Digital Building Permits for Municipalities	Link
	Paper	Investigating building permit processes across Europe: characteristics and patterns	Link
Module 3 - Interoperability, openBIM and IFC	Tables	EIR EN buildingSMART - Level of Information Need – Structures	Link
Module 5 - 3D city modelling	Dataset	Official administrative map of Portugal	Link
	Dataset	Digital elevation model of Portugal obtained by the Shuttle Radar Topographic Mission	Link
	Dataset	Map of the train network in Portugal	Link
Module 8 - Interpretation of Regulations	External documentation	CityGML Documentation	Link
	External documentation	IFC 4.0.2.1 Documentation	Link
	Regulation	Technical requirements necessary to guarantee accessibility, adaptability and visitability of private buildings and subsidized and facilitated public residential buildings	Link
	Regulation	Ordinance on general technical requirements for barrier-free use of buildings	Link

	Regulation	Laying down the general requirements for land use and the technical requirements for structures in Prague capital city	Link
	Regulation	General regulatory plan in line with the regional environmental landscape plan	Link
	Regulation	Municipal building regulations	Link
Module 9 - Integration of CHEK DBP	Deliverable	D1.1 - CHEK DBP Process Map	Link
	Deliverable	D1.2 - CHEK Maturity Model and Roadmap	Link
	CHEK outcome	CHEK To-be Digital Building Permit process map	Link

DIGITAL BUILDING PERMIT

Digital Transformation in Building Permits
Advanced Summer Course

Implementation cases

July 2025

Funded by
the European Union

Initial considerations

→ **Scope**

→ **Technical aspects**

→ **Public building x General buildings (challenges)**

→ **Things are starting**

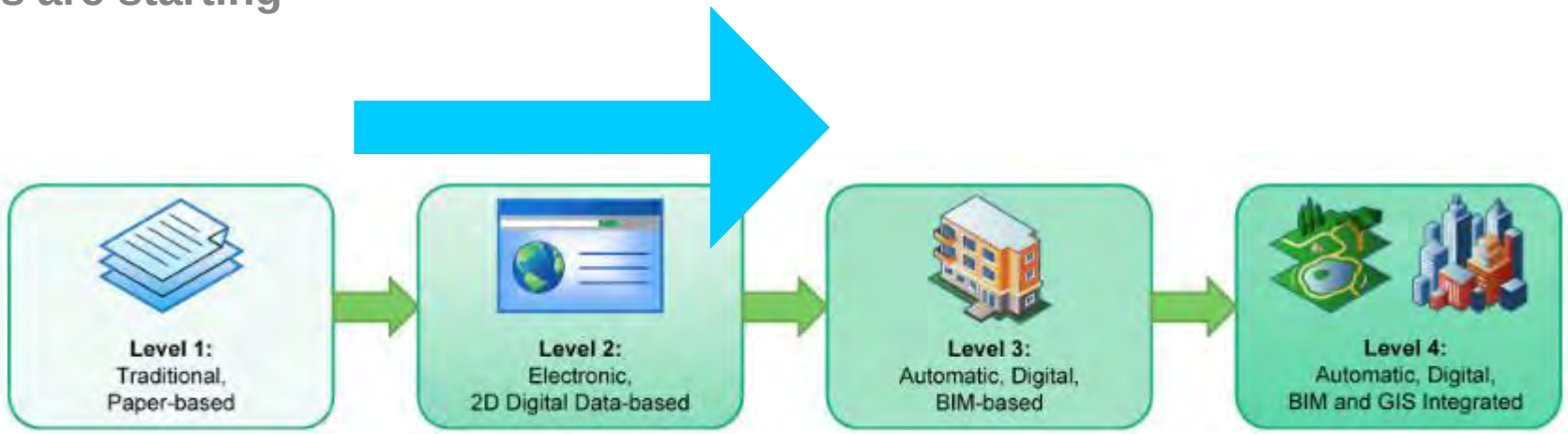
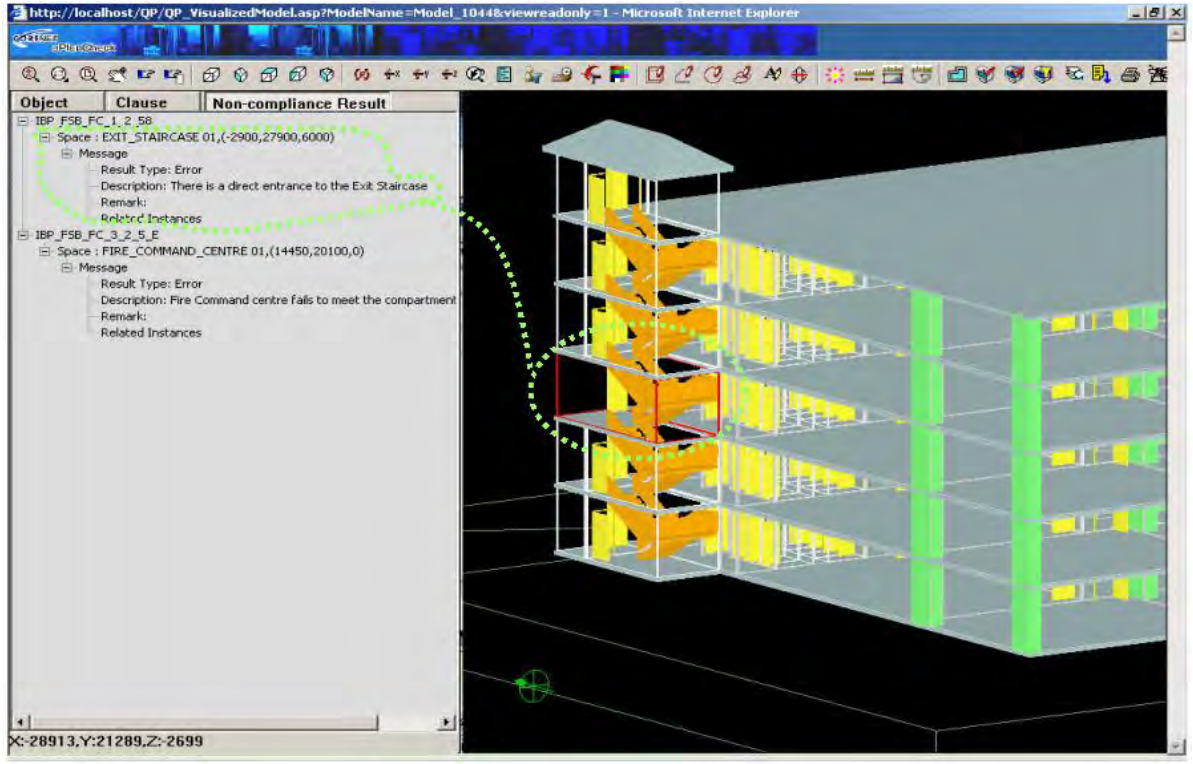


Fig. 1. Evolution of building permit issuing.
Source: Adapted from Shahi et al. [3].

F. Noardo *et al.*, 'Unveiling the actual progress of Digital Building Permit: Getting awareness through a critical state of the art review', *Building and Environment*, vol. 213, p. 108854, Apr. 2022, doi: 10.1016/j.buildenv.2022.108854.

Implementation cases

Singapore



→ Object oriented model
→ Hardcoded rules

C. Eastman, J. Lee, Y. Jeong, and J. Lee, 'Automatic rule-based checking of building designs', *Automation in Construction*, vol. 18, no. 8, pp. 1011–1033, Dec. 2009, doi: 10.1016/j.autcon.2009.07.002.

www.aecbytes.com/feature/2005/CORENETePlanCheck.html://info.corenet.gov.sg/docs/default-source/default-document-library/step-1-ifc-sg-101-(sandbox).pdf?sfvrsn=1248cc7b_1

Implementation cases

Singapore

corenetX

CORENET X Implementation Timeline



1	2	3	4	5
18 Dec 2023 Soft launch	1 Jun 2024 Voluntary submission	1 Oct 2025 Mandatory submission for new projects* with GFA ≥ 30,000m²	1 Oct 2026 Mandatory submission for all new projects*	1 Oct 2027 Mandatory onboarding for all ongoing projects**

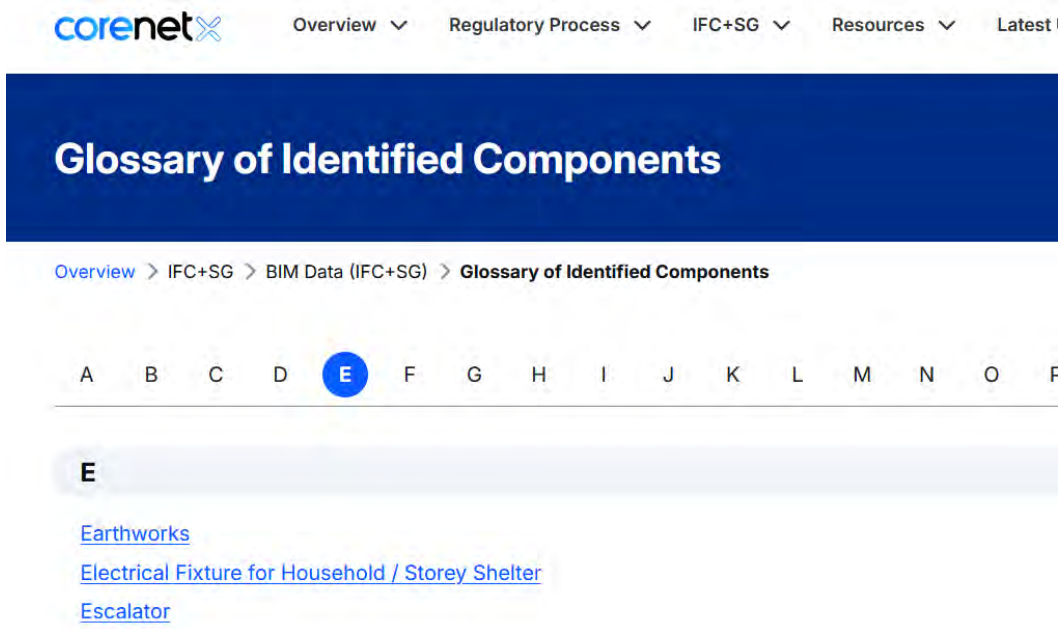
*New projects refer to projects that have not commenced application for Planning Permission to URA or application for Development Control from any of the regulatory agencies (e.g LTA, NEA, NParks, PUB)

**Ongoing Projects refer to projects that are seeking equivalent clearance(s) for Design Gateway under the RABW.

https://info.corenet.gov.sg/docs/default-source/default-document-library/step-1-ifc-sg-101-(sandbox).pdf?sfvrsn=1248cc7b_1

Implementation cases

Singapore





S4 – Fig 53 : Accessible Parking Lots

https://info.corenet.gov.sg/docs/default-source/default-document-library/step-1-ifc-sg-101-(sandbox).pdf?sfvrsn=1248cc7b_1

Implementation cases

Singapore

By IFC Representation

IFC Entity: IfcBuildingElementProxy						
IFC SubType: CARLOT, MOTORCYCLELOT, LORRYLOT, COACHLOT, ARTICULATEDVEHICLELOT						
S/N	**IFC+SG Property**	**Property Type**	**Type of Elements**	**Unit**	**Input Limitation**	**Examples**
1	BarrierFreeAccessibility	Boolean	-	-	Yes	TRUE / FALSE
2	FamilyLot	Boolean	-	-	Yes	TRUE / FALSE
3	Length	Length	-	mm	No	N.A.
4	Width	Length	-	mm	No	N.A.
5	LotNumber	Text	-	-	No	123
6	CarParking_ServedByCarLift	Boolean	-	-	Yes	TRUE / FALSE
7	MechanisedParkingSystem	Boolean	-	-	Yes	TRUE / FALSE

https://info.corenet.gov.sg/docs/default-source/default-document-library/step-1-ifc-sg-101-(sandbox).pdf?sfvrsn=1248cc7b_1

Implementation cases

United Arab Emirates - Dubai

The latest BIM mandate by Dubai Municipality issued in the Circular 9-1-2 (18/10/2023) [3] made BIM submissions in IFC format mandatory from 01/01/2024 for building permits for the following building types:

1- Buildings exceed a height of 20 floors for architectural designs and 40 floors for structural designs.

2- Buildings with an area exceeding 20,000 square meters for architectural designs and 30,000 square meters for structural designs.

3- Specialized buildings such as hospitals and universities and the like.

4- Government projects, excluding only utility infrastructure projects.





Ismail et al. Transformative Journey: Dubai Municipality's BIM Adoption for Building Permitting and Regulatory Compliance

https://eu4dbp.net/dbpc24/#book

Implementation cases

Estonia

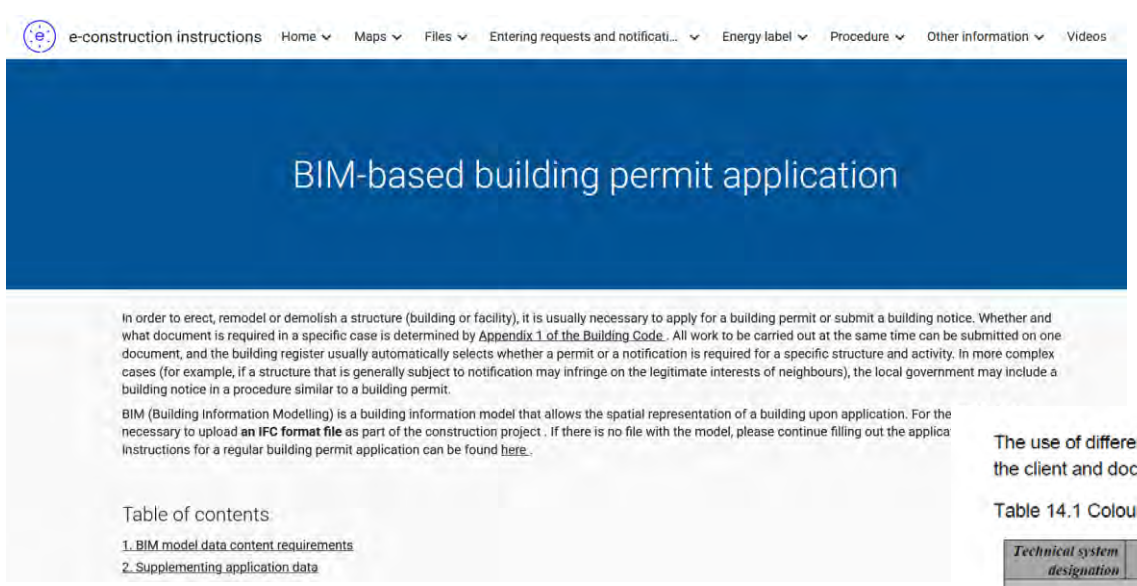


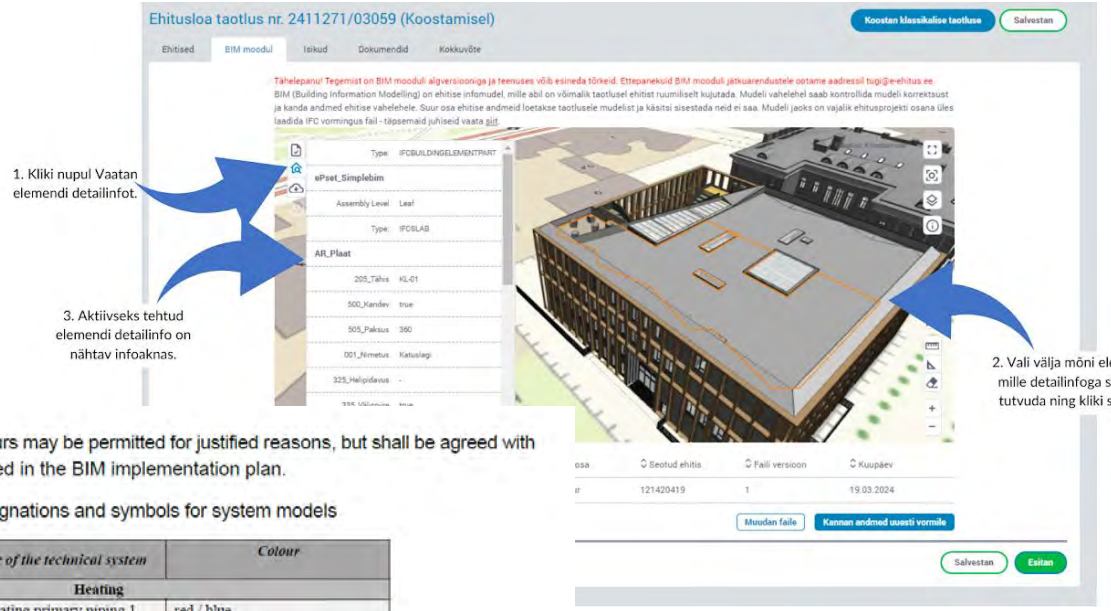
The interface of POC (source: Estonian Ministry of Economic Affairs and Communications): From Ullah et al (2020)

K. Ullah, C. Raitviir, I. Lill, and E. Witt, 'BIM adoption in the AEC/FM industry – The case for issuing building permits', *International Journal of Strategic Property Management*, vol. 26, no. 4, pp. 400–413, Oct. 2020, doi: 10.3846/ijspm.2020.13676.

Implementation cases

Estonia





The use of different colours may be permitted for justified reasons, but shall be agreed with the client and documented in the BIM implementation plan.

Table 14.1 Colours, designations and symbols for system models

Technical system designation	*Name of the technical system*	*Colour*
	Heating	
SV1	District heating primary piping 1. heat supply	red / blue
*p	*-main flow*	ACAD 10;RGB 255,0,0
*t	*-backflow*	ACAD 5; RGB 0,0,255
K21	Radiator heating system 1	purple / light blue
*p	*-main flow*	ACAD 200; RGB 191,0,255
*t	*-tagasic flow*	ACAD 140; RGB 0,191,255
K22	Radiator heating system 2	purple / light blue
*p	*-main flow*	ACAD 200; RGB 191,0,255
*t	*-tagasic flow*	ACAD 140; RGB 0,191,255

https://e-ehitus.taskugiid.eu/taotluste-ja-teatiste-sisestamine/bim-ehitusloa-taotlus

Implementation cases

Switzerland - Geneva



Submitting a building permit application in BIM format is optional; it is still possible to submit your application in classic 2D format or in paper format.

- **Step 1** : Georeferencing BIM models linked to the project
- **Step 2** : Get the initial setup to start a BIM project
- **Step 3** : Importing the AC parameters of the starter kit into the business software
- **Step 4** : Obtain the reference BIM models and integrate them into the project
- **Step 5** : BIM modeling and entering object parameters
- **Step 6** : Import IFC configuration files for IFC export
- **Step 7** : Exporting the BIM repository model
- **Step 8** : Checking the project BIM model and using the BIM Checker

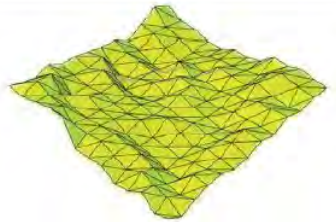
https://www.ge.ch/utiliser-bim-building-information-modeling/je-prepare-maquette-bim-autorisation-construire

Implementation cases

Switzerland - Geneva

Parcel

PARCEL	
IFC class 4	IfcGeographicElement
Code eCCC-Bat 2020	B01
Label eCCC-Bat 2020	Analysis, surveys, measurements



LOG 300

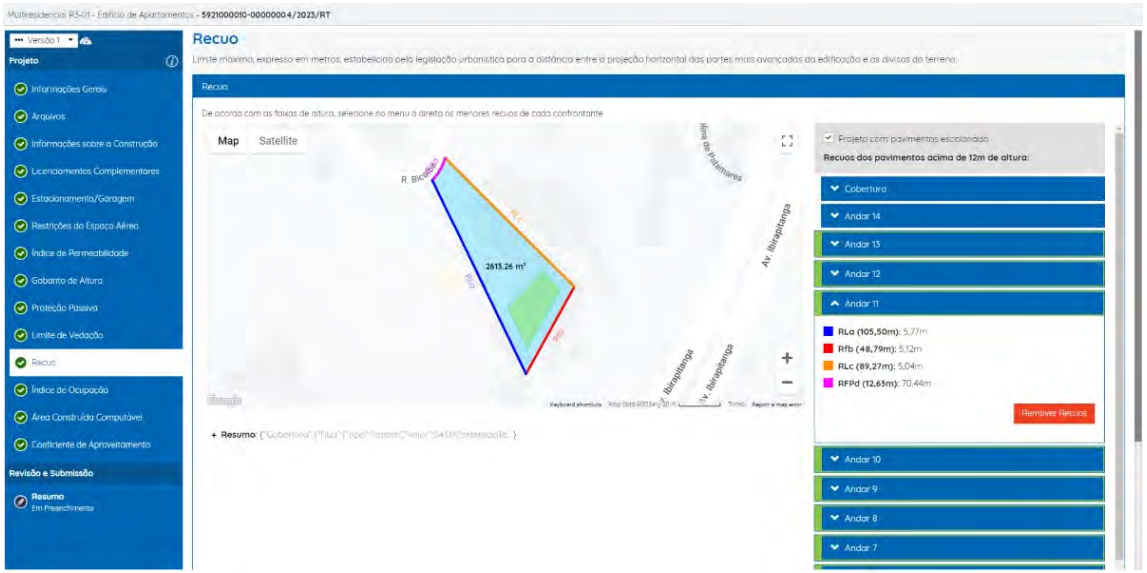
ASSOCIATED PARAMETERS

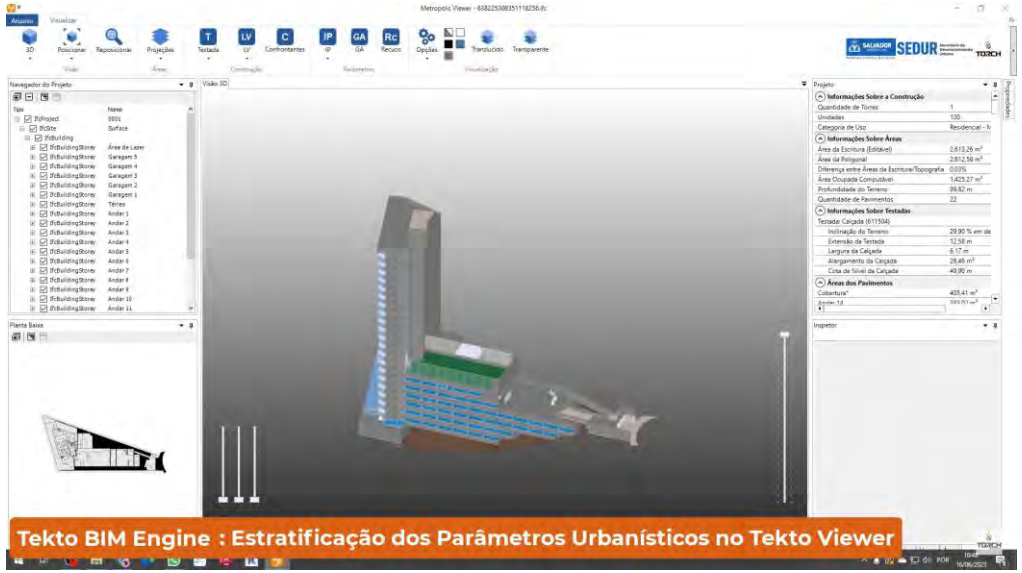
Related form	*Pset*	*Parameter name*	*Parameter type*	*Accepted values*	*Unit*	*Constraint*
	EdG_Classification	Code_eCCC_Bat_2020	Text	B01	-	Mandatory
A00	EdG_Project	Parcels__ Commune	Text		-	Mandatory
A00	EdG_Project	Parcels__ Parcel_number	Number		-	Mandatory
A00	EdG_Project	Parcels__ Concernee_parle_projet	Boolean	True / False	-	Mandatory
A00	EdG_Project	Plots__ Plot_area	Number		m^2	Mandatory
A00	EdG_Project	Parcels RDPPF_Zone_primaire__	Text		-	Mandatory
A00	EdG_Project	Parcels RDPPF_Zone_developpement__	Text		-	Mandatory

https://www.ge.ch/utiliser-bim-building-information-modeling/je-prepare-maquette-bim-autorisation-construire

Implementation cases

Brazil





'Análise da plataforma de verificação de regras de salvador, A Metropolis', in *4º congresso português de 'Building Information Modelling' vol. 2 - ptBIM*, UMinho Editora, May 2022, pp. 178–187. doi: 10.21814/uminho.ed.77.15.

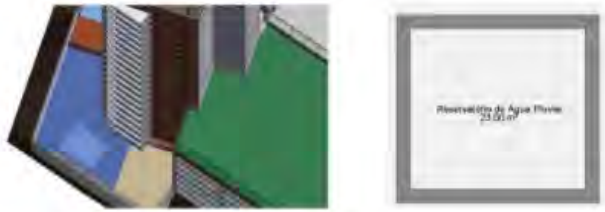
Implementation cases

Brazil

6.5 Rainwater Reservoir

If the architectural design of the project includes the collection of rainwater for reuse purposes, the Environment Identifier of the reservoir that collects this rainwater must be named "Rainwater Reservoir". This identifier must also contain information on its volume, in accordance with Figure 20.

Figure 20 – Example of Rainwater Tank with room identifier



The reservoir environment must be classified according to the specification below:

Spreadsheet Number	Metropolis Classification Table Form MS 55 25 22 00 00 00
Description	Rainwater tank
	Assista o Vídeo

https://cdn-sedur.metropolis.solutions/docs/Manual%20de%20Boas%20Pr%C3%A1ticas%20-%20Plataforma%20Metropolis.pdf

Implementation cases

Finland

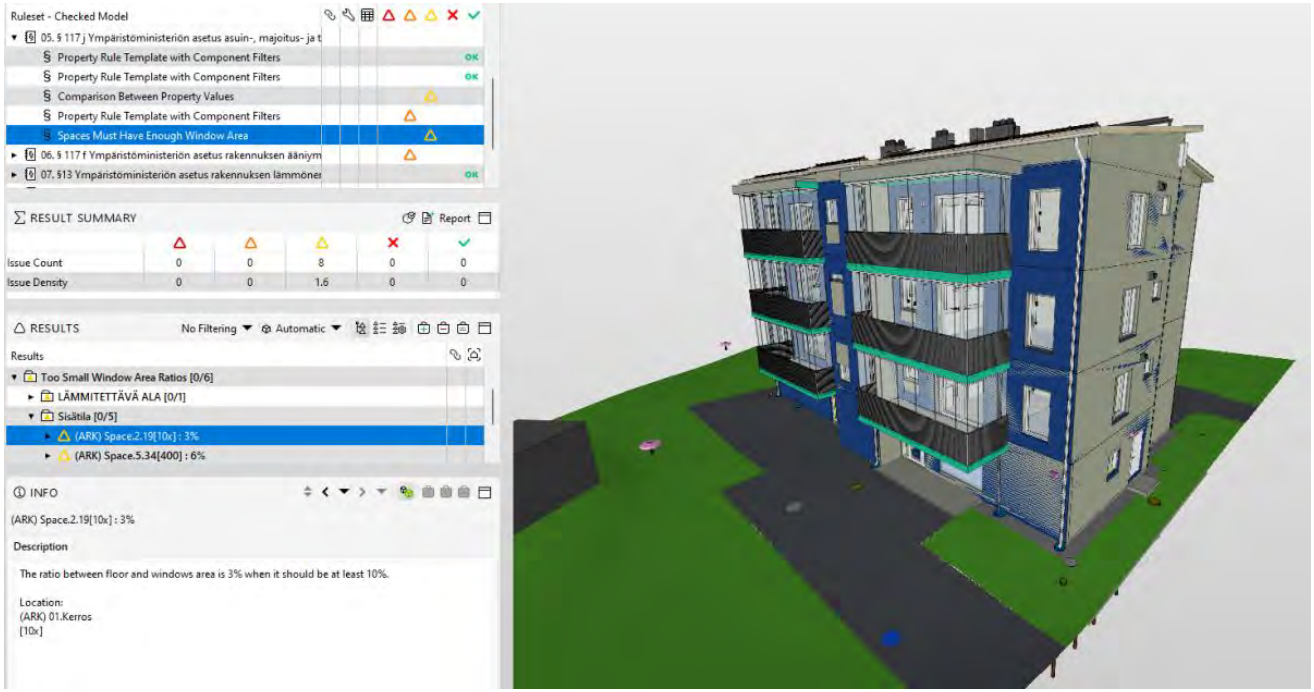
RAVA 3 PRO

- **Requirements of new COBIM2020 years 2018-2020 survey (buildingSMART Finland)**
  What were the needs for OpenBIM process in Finland (Specific requirements for IFC and Use Cases to describe the information delivery process)
- **Kiradigi pilot (RAVA1)** funded by Ministry of Enviroment of Finland year 2018
  City of Vantaa and City of Järvenpää made some first pilots for BIM-based Building Permit (Gravicon, Solibri and Sova3D was also in Project-team)
- **RAVA2** Project Ministry of Enviroment of Finland years 2020-2021
  First National Propertyset for regulatory (minimum) Building Information form BIM-based Building Permit process and first use cases surveys
- **COBIM2020 part 14** Project Ministry of Enviroment of Finland years 2021-2022
  First new COBIM part, First National Use Case for BIM-based Building Permit process
- **RAVA3Pro Project** Ministry of Economic of Finland and 23 cities years 2021-2023
  National Propertysets, Use Cases, Checking rules, BIM-based building permit automatic Checking pilots

https://kirahub.org/en/rava3pro-en/

Implementation cases

Finland



https://www.solibri.com/articles/rava3pro-and-solibri-collaborate-toward-a-digital-building-permitting-process-in-finland


CHEK
DIGITAL BUILDING PERMIT

DIGITAL BUILDING PERMIT

Digital Transformation in Building Permits

Advanced Summer Course

(WP5 Upskilling/Reskilling construction value chain

T5.3 – Technical-scientific DBP course on DBP)

July 2025

Funded by
the European Union

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1.1 Objectives

1.2 Partners

1.3 Work Packages

1.4 Pilot Cases

1.5 CHEK Online Platform and Project Outcomes

2. Advanced Summer Course

2.1 About the course

2.2 Objectives

2.3 Calendar

2.4 Venue

2.5 Teaching Staff

2.6 Modules

Objectives

CHEK – DBP (Digital Building Permit)
Horizon Europe HORIZON (out 2022 – sep 2025)

- **Goal?** Speed up the verification of regulatory compliance of works subject to prior control.
- **How?** Through the development of digital automatic verification tools (CHEK Platform).



1. Welcome to CHEK

Partners

- **Who?** 19 partners from 11 countries. Several municipalities involved: **Lisbon**, **Vila Nova de Gaia**, **Prague**, **Ascoli Piceno** and various research groups, universities and companies in the digital area of the construction industry (Architecture, Engineering, and Construction industry - AEC).

RESEARCH	SOFTWARE	DESIGN	CONSTRUCTION	MUNICIPALITIES	STANDARDIZATION
TU Delft 3Dgeoinfo	cype	SIA architects	Mostostal	LISBOA	Open Geospatial Consortium
Fraunhofer ITALIA	virtual city systems	zwei	FASADA	GAIURB.EM	buildingSMART
UNIVERSITY OF BRESCIA	Xinaps			IPR PRAGUE	
Universidade do Minho	RDF			Comune di Ascoli Piceno	
	DiRoots connecting the dots				



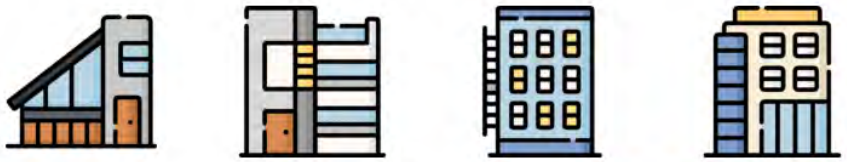
Work Packages

Work Package	Work Package name	Deliverables
WP1	The DBP process and changing strategy	D1.2, D1.3, D1.4, D1.5, D1.1
WP2	Information requirements for the DBP use case	D2.2, D2.1, D2.3, D2.4, D2.5
WP3	GeoBIM	D3.2, D3.4, D3.1, D3.3
WP4	Software development	D4.7, D4.6, D4.8, D4.4, D4.10, D4.9, D4.3, D4.1, D4.2, D4.5
WP5	Upskilling/Reskilling construction value chain	D5.4, D5.1, D5.3, D5.2
WP6	Piloting action coordination and demonstration	D6.2, D6.4, D6.5, D6.3, D6.1
WP7	Dissemination and exploitation	D7.5, D7.2, D7.4, D7.3, D7.1, D7.6
WP8	Project management	D8.7, D8.8, D8.4, D8.3, D8.2, D8.1, D8.5, D8.6

Pilot Cases

DEMONSTRATION CASES

Real-World Testing For Scalable Solutions



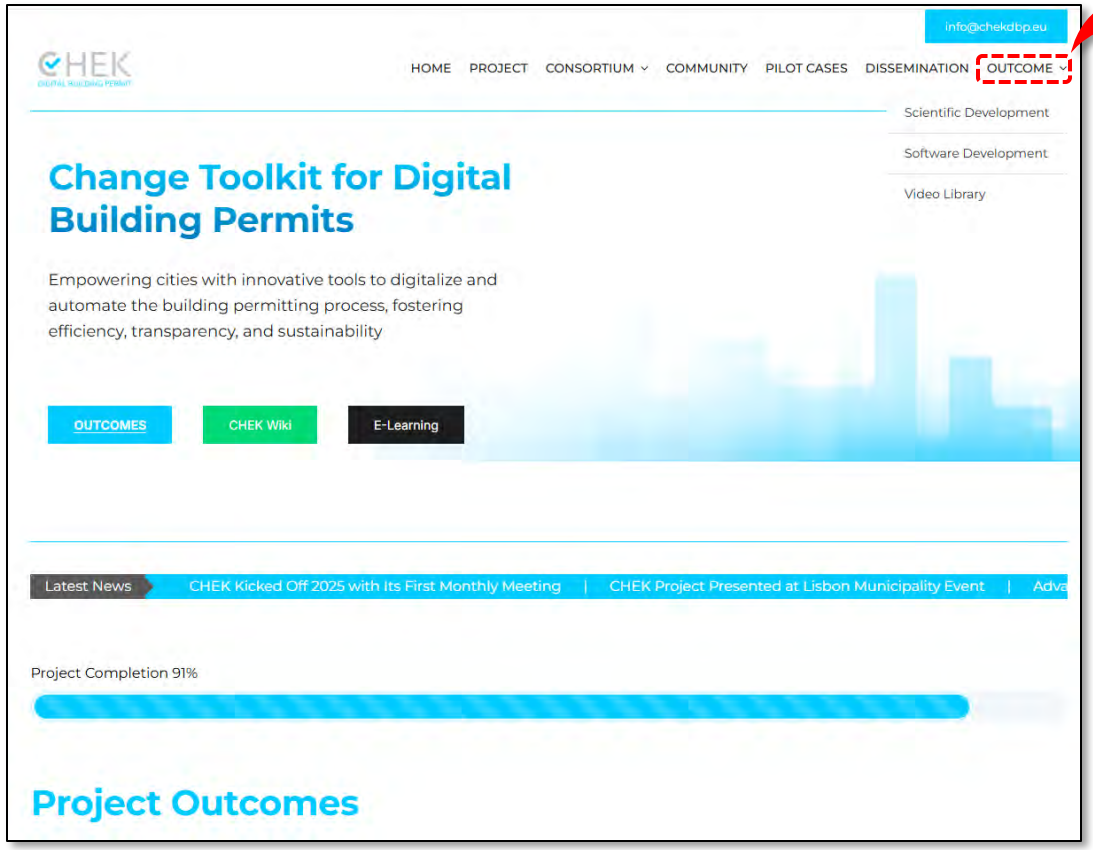
The CHEK project's pilot cases play a crucial role in demonstrating the scalability and effectiveness of the developed tools and solutions for digital building permits (DBP). These pilot cases are conducted in collaboration with **four diverse European municipalities**, representing a range of geographic, demographic, and technological characteristics. This diversity ensures that the CHEK tools can adapt to the needs of different cities across Europe.

The goal of these pilots is to test and refine the CHEK solutions in real-world scenarios, ensuring they are practical, scalable, and impactful for municipalities of all sizes.

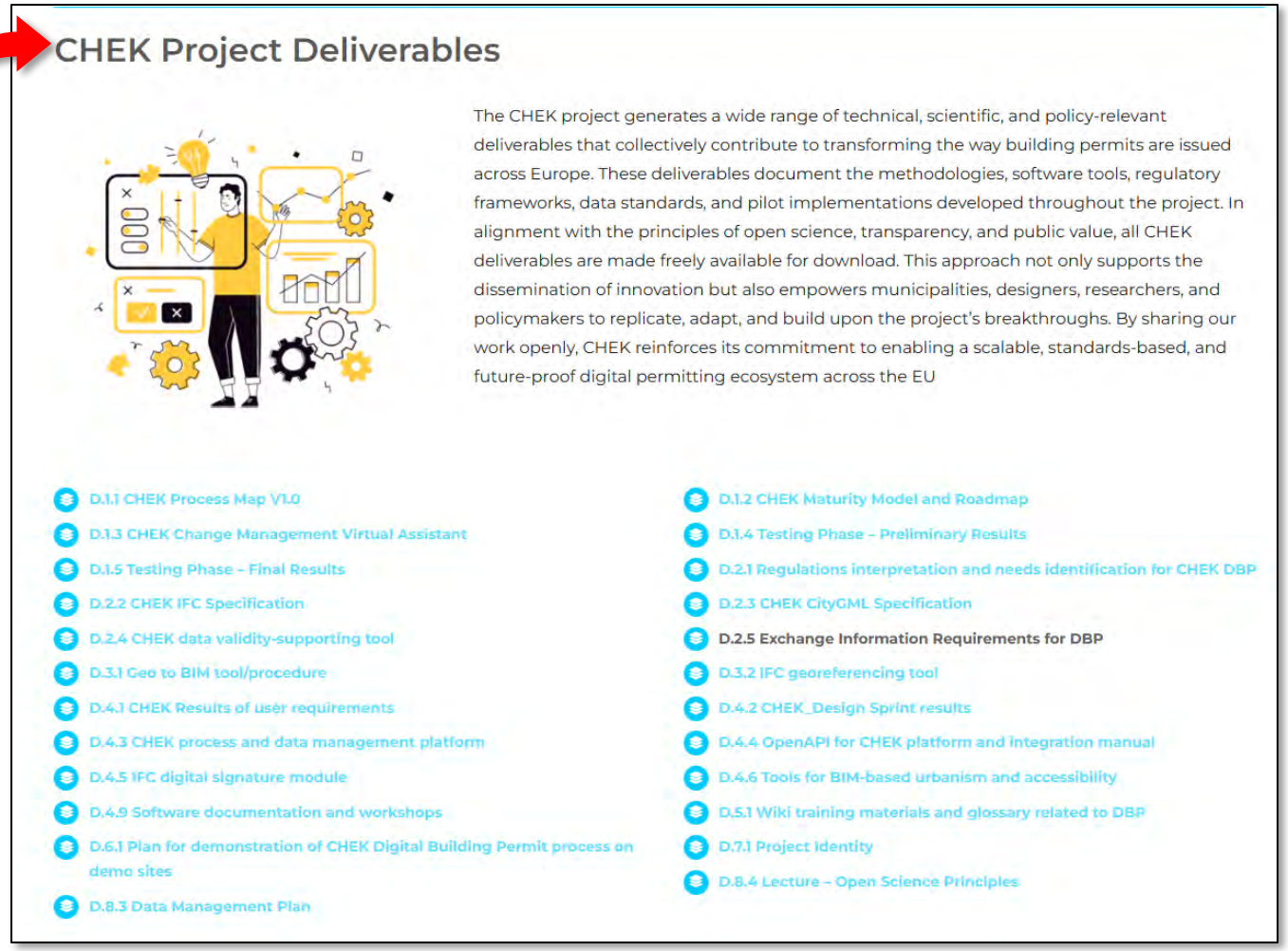
- Vila Nova de Gaia (PT)
- Lisbon (PT)
- Prague (CZ)
- Ascoli Piceno (IT)



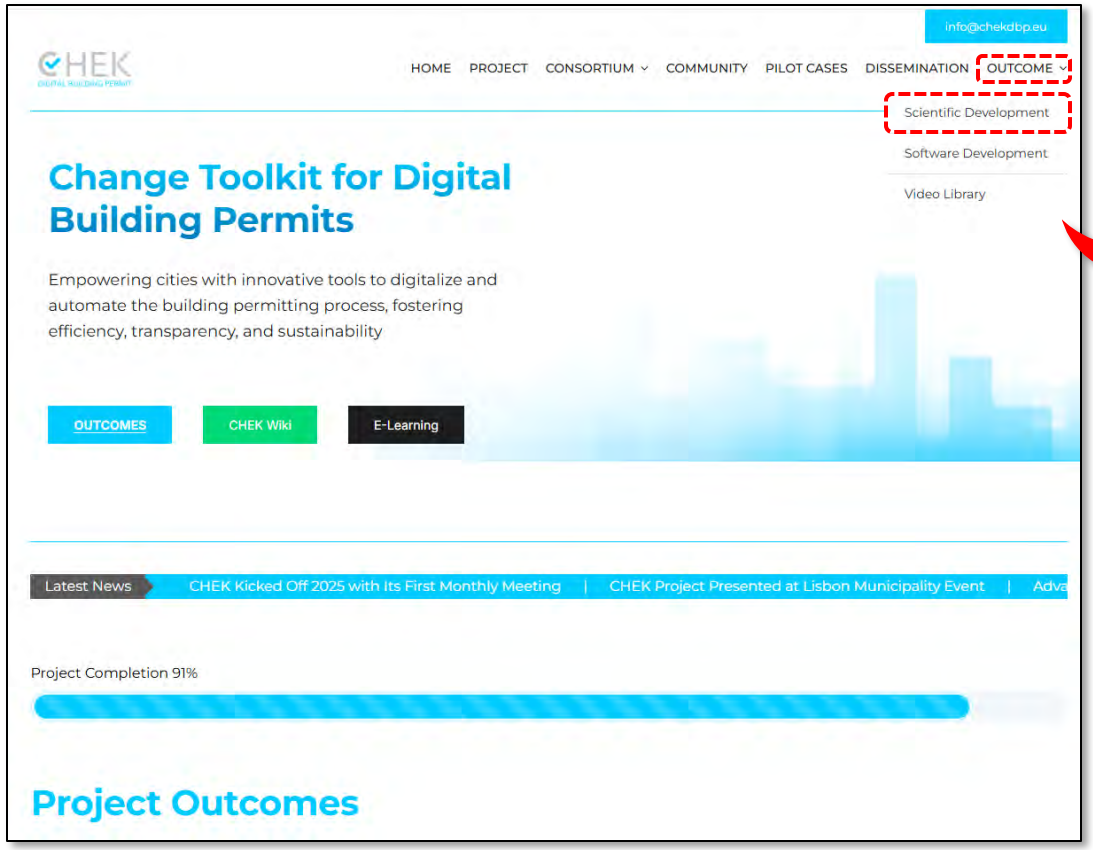
CHEK Online Platform and Project Outcomes



[CHEK platform]



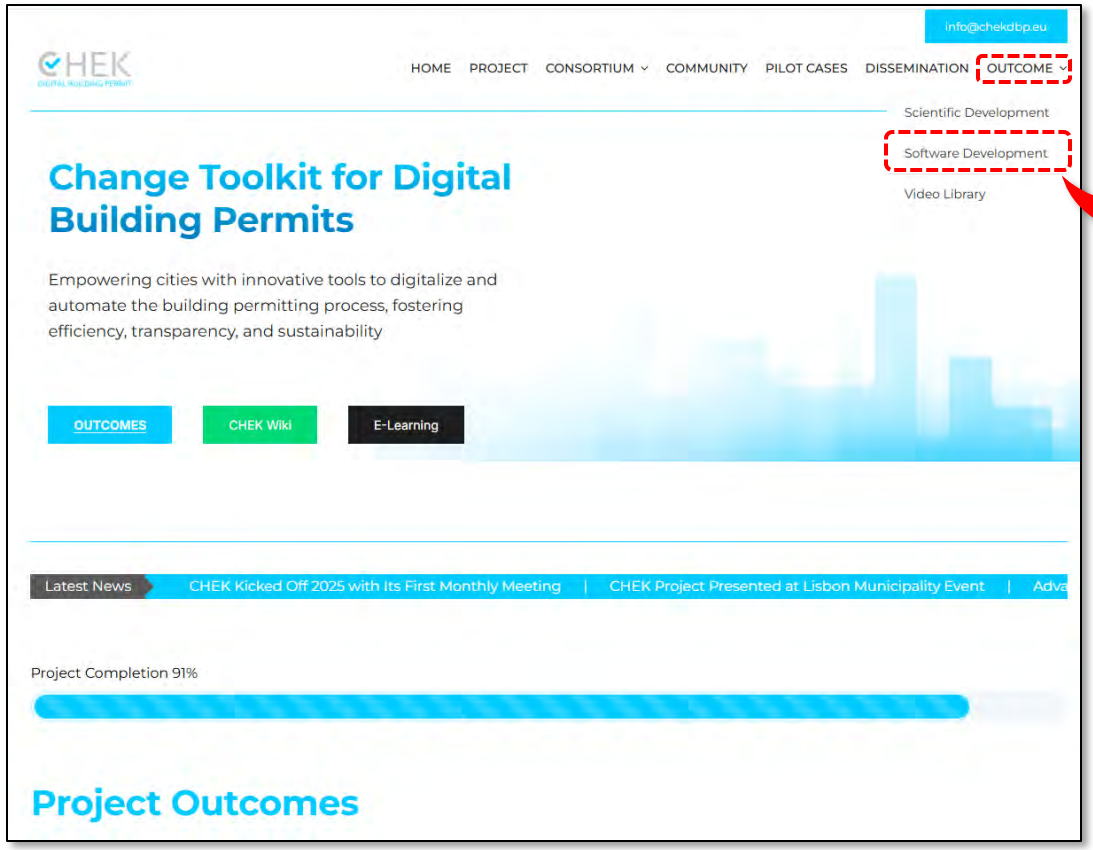
CHEK Online Platform and Project Outcomes



[CHEK platform]

Name	Partner	Description
Process Maps	FHI	The TO-BE process map illustrates the CHEK DBP process from the information collection phase to the final update of the as-built model in the city model. It reveals that the digital building permit process is complex and involves multiple steps and stakeholders. Therefore, it is essential to have a clear understanding of each step to ensure that the process runs smoothly.
Maturity Model	FHI	The main goal of the CHEK Digital Building Permit Maturity Model (CDBPMM) is to help building authorities and other organisations assess their maturity in implementing a digital building permit process. The CDBPMM defines a fully implemented and optimised digital permit process as the highest level of maturity. Using this model, organisations can evaluate their current maturity level, identify capability gaps, and develop a strategic roadmap to incrementally enhance their processes, organisation, technology, and information systems to achieve higher levels of digital integration, efficiency, quality, and transparency in permitting workflows.
CHEKWiki	UMinho	The CHEKWiki has the main goal of helping the process of upskill/reskill in the construction value chain by gathering the multidisciplinary knowledge of the partners of the CHEK consortium. Furthermore, the base of knowledge also helps to improve the communication within the project, since it contains definitions concerning terms of the building permit process of the municipalities involved, as terms of the digital domain that are related to the technologies that are going to be implemented in the project.
Entities and Attributes	UBS	Summary of entities and attributes identified through interpretation of the normative text. The data within refer to the first four control sets (distances, maximum building height, buildability index and minimum area of interior spaces) described in deliverable 2.1. In addition to containing the list of identified entities and attributes, this table contains an in-depth analysis of attributes. Precisely, the type of data (e.g., numeric, alphanumeric, boolean), the unit of measurement, the type of value (e.g., float numeric, integer numeric, classification), the comparative (e.g., =,>,<), if the data is numeric, the value is specified, while if the data refers to a list, the classification is specified, and finally, the regulation and municipality in which the attribute emerges.
LOIN	UBS	From the interpretation of the normative text and conceptual models, information requirements were identified with reference to standard EN 17412-1:2020. Information requirements contain geometrical information (e.g., detail, location, appearance), alphanumerical information (e.g., identification, information content) and documentation. This table is under development. To date, it contains LOINs referring to the first four control sets (distances, maximum building height, buildability index and minimum area of interior spaces) for the municipality of Ascoli Piceno, Italy
CHEKClauses	UMinho	The CHEKClauses base in Airtable is being developed as a centralized source of information about the regulatory analysis in the project. The goal is to streamline the delivery of information to other teams within the project related to the information requirements and software implementation.
IFC CHEK (IDS and PSD files)	RDF	CHEK IFC is a standardized solution to allow automated validation.

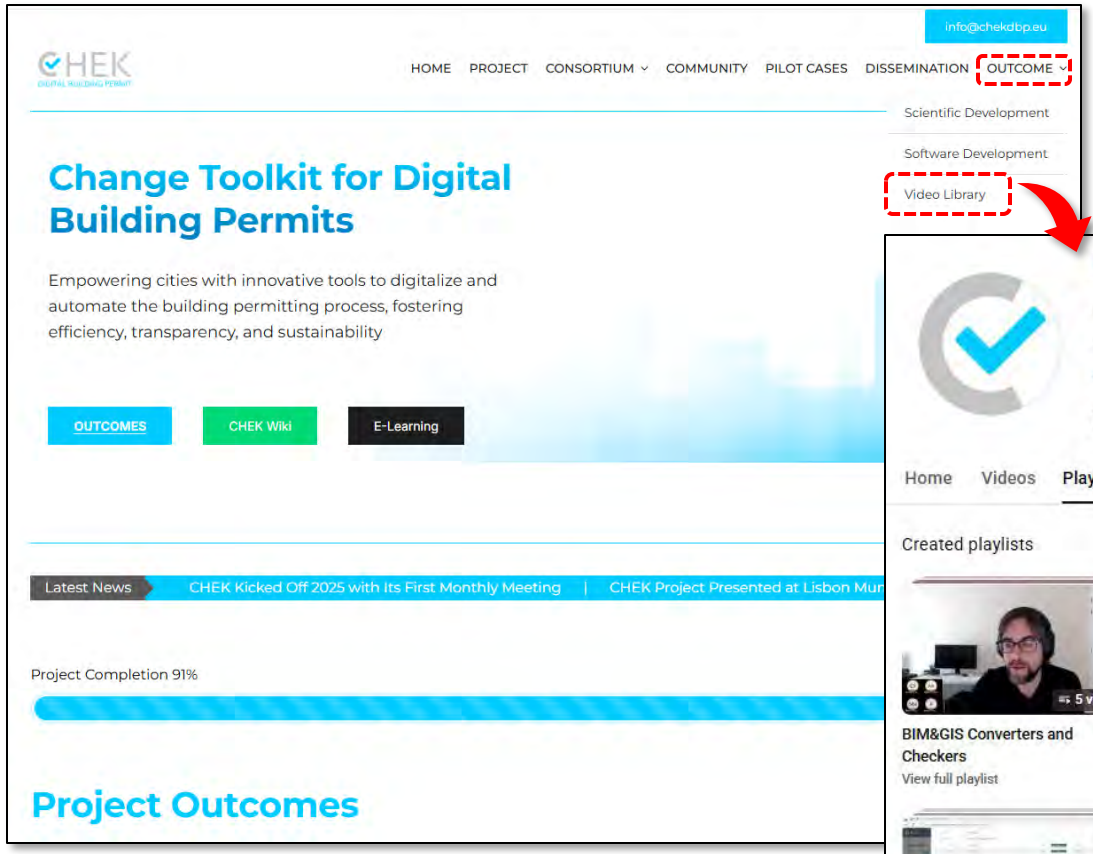
CHEK Online Platform and Project Outcomes

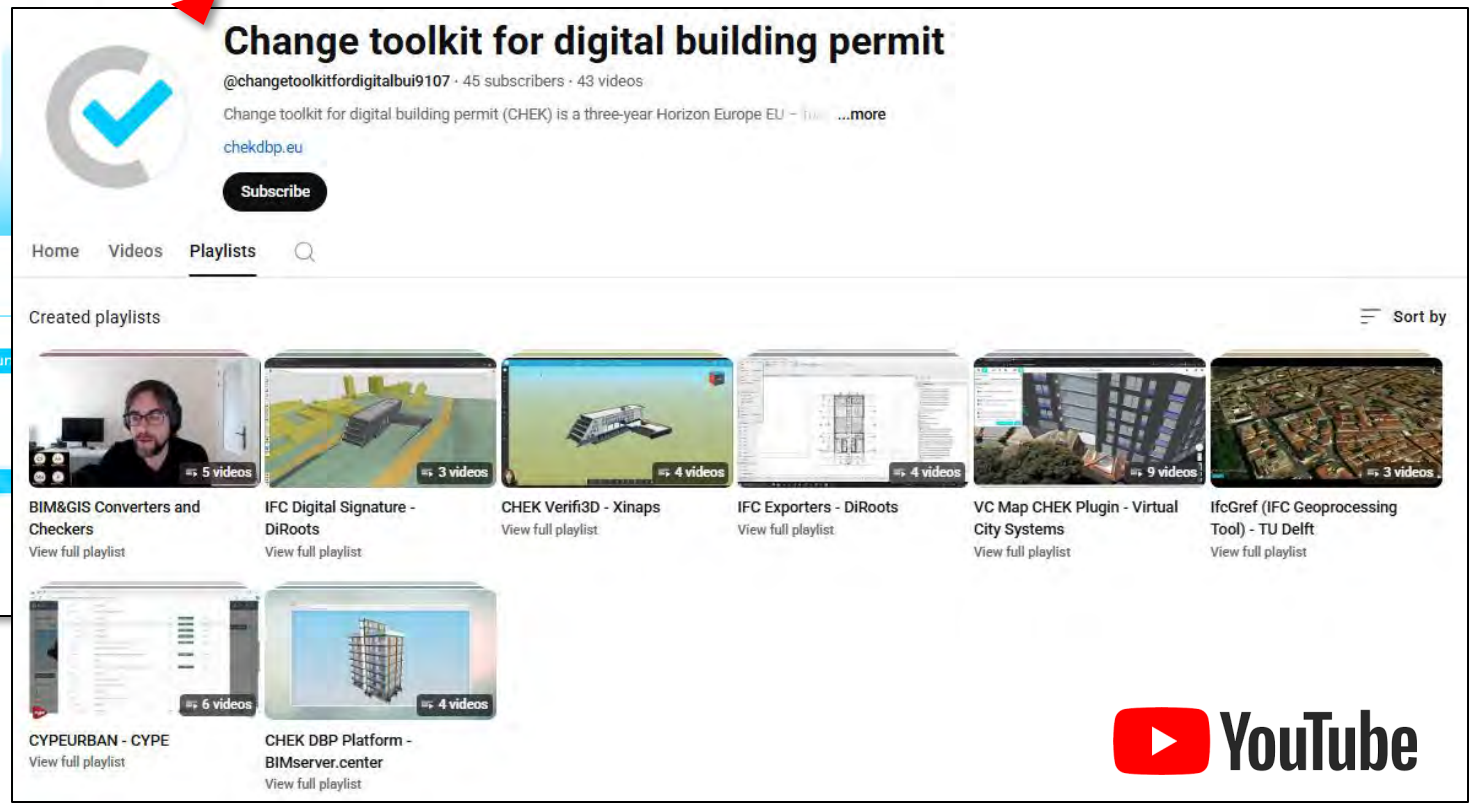


[CHEK platform]

Tool name	Partner	Description
API REST	CYPE	The API REST for BIMserver.center is an Open API that provides the necessary framework for any software or service to access and manage data in BIMserver.center platform. The API will facilitate communication and interoperability between the different tools and services that CHEK will provide for the digital building permit process.
Bimserver.center	CYPE	BIMserver.center Validation provides a framework for public and private institutions which daily work is dealing with building permitting processes. BIMserver.center Developers is specific part of BIMserver.center from which any software developer can manage access to BIMserver.center from their applications through the API.
CYPEURBAN	CYPE	CYPEURBAN is a free program for carrying out urban planning compliance documents on BIM models in IFC format. The program includes logical calculation which allows users to obtain some of the urban planning checks required by municipal bylaws from the BIM model. It also includes a series of tools for defining and checking parameters such as distances from the building to adjoining plots, plot checks, occupancy, buildability, crown height and free heights, among others.
Open BIM Accessibility	CYPE	Open BIM Accessibility is a tool for the analysis and verification of accessibility requirements in building projects. The application allows the customization of the regulatory accessibility requirements to be examined. The software imports IFC models to check against accessibility rules.
Open BIM Site	CYPE	Open BIM Site is a free application for defining the initial conditions of a project site. Using this tool, users can establish the geographical location of the models, manage different types of maps, enter topographic surfaces and add elements specific to the site, such as parcels and buildings.
IFC Digital Signature	DiRoots	The IFC Digital Signature core service includes two main components: the IFC signing and the signature validator. Designed with a modular, decoupled architecture, this service supports a variety of integrations and workflows. The IFC signing component retrieves necessary data from an IFC file to secure a digital signature from supported providers, which is then attached directly to the file without altering its structure. The validator module enables compliant IFC files to display a visual indicator of the signature's validity, ensuring the file has not been tampered with and maintaining trust between the creator and user. This flexible system is compatible with any eIDAS trusted provider for strong legal compliance and can also integrate with bespoke in-house solutions, enhancing its adaptability for secure digital practices.

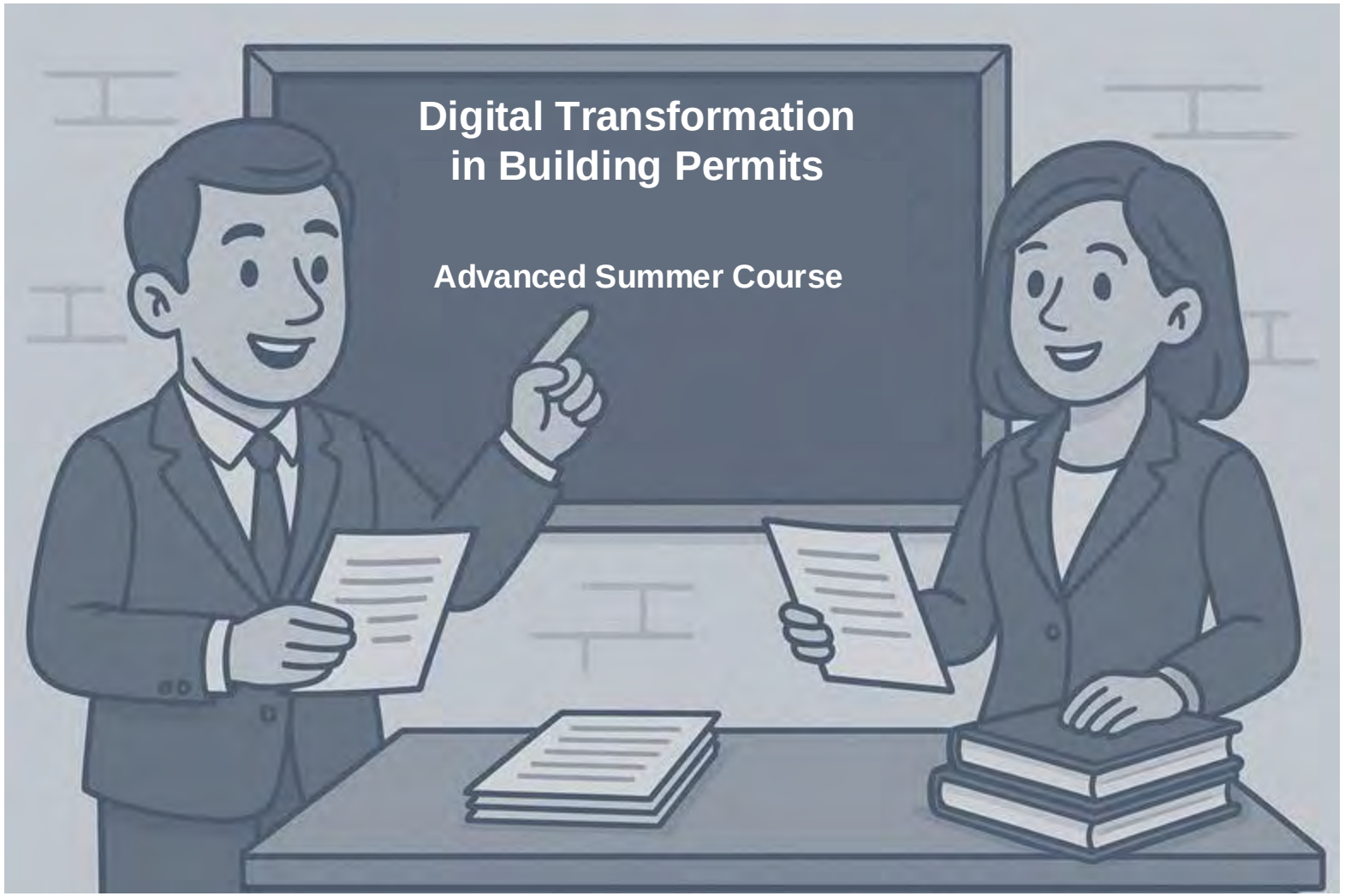
CHEK Online Platform and Project Outcomes





[CHEK platform]

Let’s now briefly introduce the advanced summer course…



2. Advanced Summer Course

About the course

- An intensive one-week summer course designed to equip participants with cutting-edge knowledge and practical skills in the digitalization of building permit processes.

- This course delves into advanced topics such as BIM standardization, interoperability, GIS integration, legal frameworks, and the application of tools developed in the CHEK Digital Building Permits Project.

- Participants will engage with leading experts from the Academia and Industry, gaining insights into the latest developments and practices in the field.



2. Advanced Summer Course

Objectives

- Understand Digital Building Permits: Explore the evolution, current state, and standards (e.g., ISO 19560) driving the digital transformation of building permits.
- Master Technical Tools: Gain expertise in BIM interoperability, GIS, CityGML, and the Digital City Register for managing spatial and urban data.
- Analyze Legal Frameworks: Understand and interpret building permit laws and regulations in the context of digital workflows.
- Integrate Law and Technology: Learn how legal principles and digital technologies converge to enable automated digital building permit processes.
- Apply CHEK Tools: Use practical examples and software tools from the CHEK project to address challenges in digital building permits.

2. Advanced Summer Course

Calendar

Day	Module	Venue
07/07 – Morning	Module 1 – Introduction and State of the Art on Building Permits	GAIURB
07/07 – Afternoon	Module 2 – BIM Standardization	GAIURB
08/07 – Morning	Module 3 – Interoperability, openBIM and IFC	Univ. of Minho
08/07 – Afternoon	Module 4 – Interoperability beyond IFC	Univ. of Minho
09/07 – Morning	Module 5 – 3D city modelling: background and standards	Univ. of Minho
09/07 – Afternoon	Module 6 – Creation of 3D city models and GeoBIM integration	Univ. of Minho
10/07 – Morning	Module 7 – Building Permits Law	Univ. of Minho
10/07 – Afternoon	Module 8 – Interpretation of Regulations: workshop	Univ. of Minho
11/07 – Morning	Module 9 – Integration of CHEK DBP Process and Digital Technologies for DBP Automation	Univ. of Minho
11/07 – Afternoon	Module 10 – Tools and practical examples of CHEK DBP	Univ. of Minho

Venue

University of Minho
Campus de Couros
Guimarães
PORTUGAL

Universidade do Minho





GAIURB
Largo de Aljubarrota 13
Vila Nova de Gaia
PORTUGAL

GAIURB.EM

Couros Campus

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Ane Ferreiro
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Bruno Muniz
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OGC



Elisa Dutsch
Virtual City Systems (VCS)



Christian Friedrich
Xinaps



Ken Arroyo Ohori
Delft University of Technology



Silvia Mastrolembo
University of Brescia



Luiggi Alfaro
DiRoots



Carla Pires
GAIURB



Sara Comai
University of Brescia



Kavita Raj
University of Brescia



Patrícia Baptista
GAIURB



Marco Lima
GAIURB



Chiara Micera
Studio Legale Micera



Dietmar Siegele
Fraunhofer Italia



Angelo Ciribini
University of Brescia

Modules

Module 1 – Introduction and State of the Art on Building Permits

- Introduction of CHEK project and its role in advancing digital building permit (DBP) processes.
- It presents key research works on DBP, offering insights into current challenges and innovations.
- A visit to a building permit department will provide practical exposure to real-world workflows.
- Additionally, the module explores the state of the art of digital building permits, highlighting its trends and developments in several countries.

Modules

Module 2 – BIM standardization (blended with Module 1,3,4; added team based learning activity)

- Overview of the standards related to the implementation of BIM.
- It covers ISO 7817 (Level of Information Need), ISO 23386 and ISO 23387 (Product Data Templates), and ISO 12006-2 (Classification Systems).
- Additionally, it explores ISO 19560, detailing concepts, principles, and processes for managing information throughout the asset lifecycle, from requirements definition to the delivery phase.

Modules

Module 3 – Interoperability, openBIM and IFC

- Introduction of advanced topics on interoperability, focusing on the role of OpenBIM and buildingSMART in enabling seamless data exchange through the development of open formats.
- It covers different types of BIM tools, the importance of interoperability, and the principles of OpenBIM. A deep dive into IFC (Industry Foundation Classes) explores its history, schema, file structure, and key elements.
- Practical aspects include georeferencing in IFC, coordinate reference systems, and techniques for analyzing IFC files using viewers and text editors.

Modules

Module 4 – Interoperability beyond IFC

- A structured understanding of information exchange in BIM, focusing on Model View Definitions (MVD), Information Delivery Specifications (IDS), the buildingSMART Data Dictionary (bsDD), and the BIM Collaboration Format (BCF).
- It explores how these concepts facilitate interoperability and structured data exchange.
- Practical insights include defining IDS, exploring bsDD, using BCF for communication, and managing information in a CDE.

Modules

Module 5 – 3D city modelling: background and standards

- Explanation on how cities are modelled in 3D.
- 1st part: An overview of the relevant background concepts and methods, mainly covering topics from 2D and 3D GIS, such as the representation of geometry, topology and semantics, georeferencing and projections, and a sample of processing techniques and software.
- 2nd part: A technical overview of 3D city modelling, including concepts such as semantic surfaces and templates, and concretely how different classes of objects are modelled according to the standards that are used for it.

Modules

Module 6 – Creation of 3D city models and GeoBIM integration

- Explanation on how 3D city models can be created and processed, as well as how they can be integrated with BIM models.
- 1st part: Presentation of methodologies that can be used to jointly process and merge different typical 2D datasets to create a 3D city model, including a demonstration of 3dfier using 2D topographic data and a point cloud.
- 2nd part: Theoretical and practical aspects behind GIS and BIM integration (GeoBIM), including relevant concepts from integration and interoperability, as well as the conversion from Geo to BIM and vice versa.

Modules

Module 7 – Building Permits Law

- An overview of Public Administration processes and to know a methodology for interpreting regulatory regulations.
- The speech will focus on legal reflections on the issue of automation of decision-making processes of the Public Administration in the European legal framework.
- The exhibition will have an in-depth look at the use of building information modelling and artificial intelligence.
- A manual methodology for analysing regulations and identifying information requirements is proposed.
- Using labelling, objects and properties are defined, then standardized according to widely used BIM and GIS standards.

Modules

Module 8 – Interpretation of Regulations: workshop

- The workshop aims to teach a methodology for analyzing regulations to define information requirements and verification logic.
- Participants will identify elements required in building and city models and apply a labeling approach to structure data from regulations in tabular form.
- The session also introduces OpenAI tools, covering GPT customization, prompt design, and automating regulation analysis.
- Through hands-on exercises and demonstrations, attendees will test AI performance, reflect on challenges, and explore next steps, gaining skills to apply AI-driven solutions in regulatory contexts.

Modules

Module 9 – Integration of CHEK DBP Process and Digital Technologies for DBP Automation

- This advanced module explores the CHEK project's integration of process mapping and digital tools to transform building permit workflows.
- Participants analyze "as-is" processes through municipal workshops, identifying inefficiencies and bottlenecks, then design optimized "to-be" systems with BIM/GIS interoperability, automated rule-checking, visual inspection platforms, and digital signatures.
- The project's modular digital infrastructure supports scalability, compliance, and centralized data management, guided by KPIs like transparency and efficiency.
- A hands-on workshop enables attendees to create tailored "to-be" process maps, applying these tools to minimize delays, reduce errors, and adapt solutions to regional regulations.
- Emphasizing user-friendliness for municipalities and applicants, the module equips learners to drive efficient, transparent, and scalable permit systems.

Modules

Module 10 – Tools and practical examples of CHEK DBP

- During this session an overview of CHEK tools and workflow will be provided.
- After this general overview, some of the tools will be explained in depth.
- The objective of the initial overview is to take a look to all the tools that are relevant for de Digital Building Permit, not all these tools will be explained in depth as we don't have the time to do so (IFC Checkers, CityGML Checks, IDS Exporters.
- In the second part we will put emphasis in three aspects: the DBP management platform both for designers and municipalities, site and architecture models and we will finalize with different types of checking tools that are portrayed in the project.
- The session will have practical examples that will be accessible and provided to the students. The idea is to explain and provide access to students to the tools but not for the students to use the tools live during the session.

3. Additional information

- Get contents from elearning platform elearning.chekdbp.eu (permanently updated)
- Self-register attendance on the elearning platform
- Lunches: today we have reserved a restaurant (each responsible for their payment). On all other days, the organization provides lunch.
- Any doubts?

- Round of self-presentations


CHEK
DIGITAL BUILDING PERMIT

DIGITAL BUILDING PERMIT

BIM Standardization

CHEK Summer Course

Miguel Azenha, José Granja, Bruno Muniz

ISISE, University of Minho, PORTUGAL

Funded by
the European Union

What is BIM?

Some keywords:

- Methodology
- Information sharing and communication
- Construction / built environment (not buildings only)
- All stakeholders
- All stages
- (May use) 3D Digital model/representation

“Building” …. “Information”… “Modelling”….



The three great layers of standardization in BIM @ EU



buildingSMART International home of openBIM

ISO/TC 59/SC 3

buildingSMART International home of openBIM

CEN TC 442 BIM

Different in each country...

CT197 BIM

buildingSMART Portugal

IPQ CT197- BIM

ISO / TC 59 / SC13

← ISO/TC 59

ISO/TC 59/SC 13

Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM)

Scope

SC 13 is charged by TC 59 to focus on international standardization of information through the whole life cycle of buildings and infrastructure across the built environment

- to enable interoperability of information;
- to deliver a structured set of standards, specifications and reports to define, describe, exchange, monitor, record and securely handle information, semantics and processes, with links to geospatial and other related built environment information;
- to enable object-related digital information exchange.

https://www.iso.org/committee/49180.html

Reference ↑	Title
ISO/TC 59/SC 13/JWG 12	Joint ISO/TC 59/SC 13 - ISO/TC 184/SC 4 WG: Development of building data related standards
ISO/TC 59/SC 13/JWG 14	Joint ISO/TC 59/SC 13 - ISO/TC 211 WG: GIS-BIM interoperability
ISO/TC 59/SC 13/TF 1	Terminology
ISO/TC 59/SC 13/TF 2	Business Planning and Strategy
ISO/TC 59/SC 13/WG 2	Classification of the information on the construction industry
ISO/TC 59/SC 13/WG 6	Framework for object-oriented information exchange
ISO/TC 59/SC 13/WG 8	Building information models - Information delivery manual
ISO/TC 59/SC 13/WG 11	Product data for building services systems model
ISO/TC 59/SC 13/WG 13	Implementation of collaborative working over the asset lifecycle

ISO 19650 Series

link

ISO 19650-1:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling — Part 1: Concepts and principles	90.92	93.010 35.240.67 91.010.01
ISO 19650-2:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling — Part 2: Delivery phase of the assets	90.92	93.010 35.240.67 91.010.01
ISO 19650-3:2020 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling — Part 3: Operational phase of the assets	90.92	93.010 35.240.67 91.010.01
ISO 19650-4:2022 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling — Part 4: Information exchange	60.60	93.010 35.240.67 91.010.01
ISO 19650-5:2020 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling — Part 5: Security-minded approach to information management	60.60	93.010 35.240.67 91.010.01
ISO 19650-6:2025 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling — Part 6: Health and safety information	60.60	93.010 35.240.67 91.010.01

ISO 7817-1:2024 Building information modelling — Level of information need — Part 1: Concepts and principles	60.60	35.240.67 91.010.01	Level of Information Need
ISO 12006-2:2015 Building construction — Organization of information about construction works — Part 2: Framework for classification	90.92	91.010.01	
ISO 12006-3:2022 Building construction — Organization of information about construction works — Part 3: Framework for object-oriented information	60.60	91.010.01	Data Dictionaries 12006
ISO 12911:2023 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Framework for specification of BIM implementation	60.60	91.010.01	
ISO 16354:2013 Guidelines for knowledge libraries and object libraries	90.93	91.010.01	
ISO 16739-1:2024 Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries — Part 1: Data schema	60.60	25.040.40	IFC Schema – 4.3 -> 2024!
ISO 16757-1:2015 Data structures for electronic product catalogues for building services — Part 1: Concepts, architecture and model	90.93	91.010.01	
ISO 16757-2:2016 Data structures for electronic product catalogues for building services — Part 2: Geometry	90.93	91.010.01	

ISO 21597-1:2020 Information container for linked document delivery — Exchange specification — Part 1: Container	60.60	35.240.67 91.010.01	
ISO 21597-2:2020 Information container for linked document delivery — Exchange specification — Part 2: Link types	60.60	35.240.67 91.010.01	
ISO 22263:2008 Organization of information about construction works — Framework for management of project information	90.93	91.010.01	
ISO/TR 23262:2021 GIS (geospatial) / BIM interoperability	60.60	35.240.67 35.240.70	BIM / GIS
ISO 23386:2020 Building information modelling and other digital processes used in construction — Methodology to describe, author and maintain properties in interconnected data dictionaries	90.20	35.240.67	PDTs, objects
ISO 23387:2020 Building information modelling (BIM) — Data templates for construction objects used in the life cycle of built assets — Concepts and principles	90.92	35.240.67 91.010.01	
ISO 29481-1:2016 Building information models — Information delivery manual — Part 1: Methodology and format	90.92	35.240.67 91.010.01	
ISO 29481-2:2012 Building information models — Information delivery manual — Part 2: Interaction framework	90.92	35.240.67 91.010.01	IDM
ISO 29481-3:2022 Building information models — Information delivery manual — Part 3: Data schema	60.60	35.240.67 91.010.01	

← ISO/TC 10

ISO/TC 10/SC 8

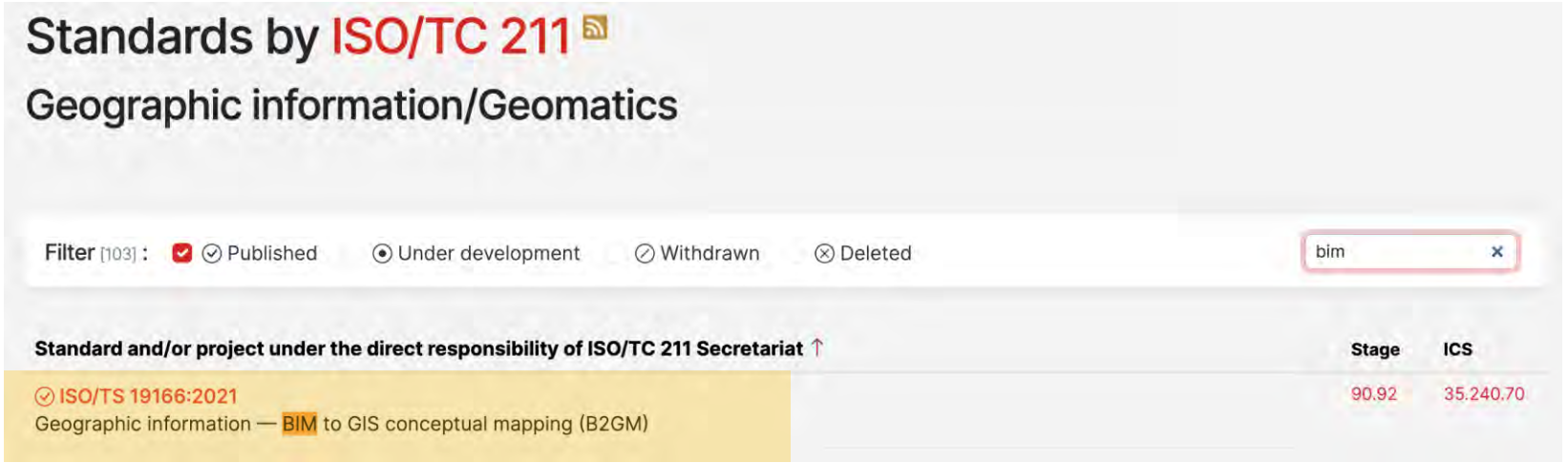
Construction documentation

(...)

ISO 7437:1990 Technical drawings — Construction drawings — General rules for execution of production drawings for prefabricated structural components	90.93	01.100.30
ISO 7518:1983 Technical drawings — Construction drawings — Simplified representation of demolition and rebuilding	90.93	01.100.30
ISO 7519:2025 Technical product documentation (TPD) — Construction documentation — General principles of presentation for general arrangement and assembly drawings	60.60	01.100.30
ISO 8560:2019 Technical drawings — Construction drawings — Representation of modular sizes, lines and grids	90.60	01.100.30
ISO 9431:1990 Construction drawings — Spaces for drawing and for text, and title blocks on drawing sheets	90.60	01.100.30
ISO 11091:1994 Construction drawings — Landscape drawing practice	90.20	01.100.30
ISO 13567-1:2017 Technical product documentation — Organization and naming of layers for CAD — Part 1: Overview and principles	90.93	01.110 35.240.10
ISO 13567-2:2017 Technical product documentation — Organization and naming of layers for CAD — Part 2: Concepts, format and codes used in construction documentation	90.93	01.110 35.240.10
ISO/TR 16310:2014 Symbol libraries for construction and facilities management	60.60	01.100.30
ISO 22014:2024 Library objects for architecture, engineering, construction and use	60.60	01.100.30 35.240.67 91.010.01

Library objects

Other TCs in ISO



BIM to GIS !

The three great layers of standardization in BIM @ EU



buildingSMART International home of openBIM

ISO/TC 59/SC 3

buildingSMART International home of openBIM

CEN TC 442 BIM

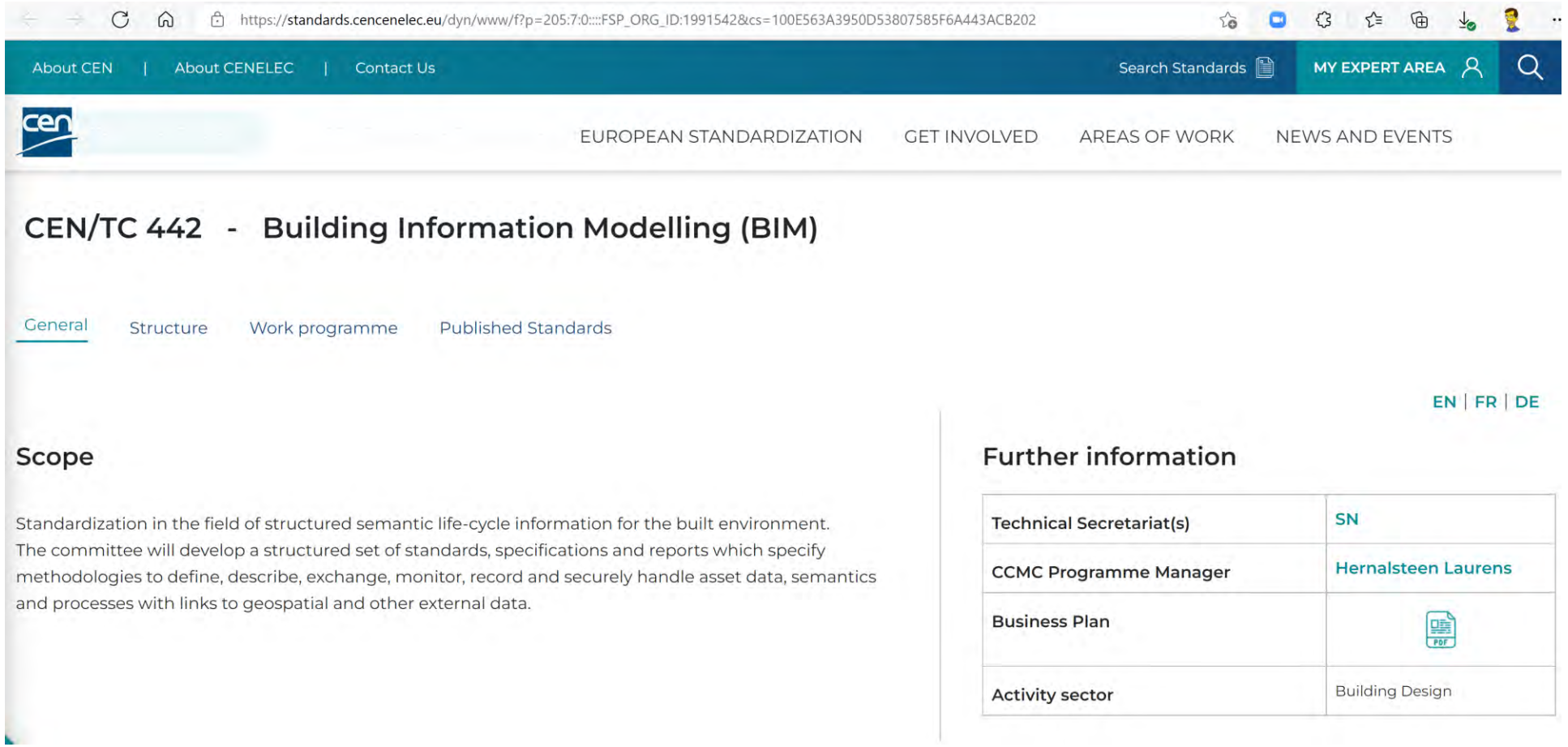
Different in each country...

CT197 BIM

buildingSMART Portugal

IPQ CT197- BIM

CEN TC 442



https://standards.cencenelec.eu/dyn/www/f?p=205:7:0::::FSP_ORG_ID:1991542&cs=100E563A3950D53807585F6A443ACB202

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EUROPEAN STANDARDIZATION GET INVOLVED AREAS OF WORK NEWS AND EVENTS

CEN/TC 442 - Building Information Modelling (BIM)

General Structure Work programme Published Standards

EN | FR | DE

Scope

Standardization in the field of structured semantic life-cycle information for the built environment. The committee will develop a structured set of standards, specifications and reports which specify methodologies to define, describe, exchange, monitor, record and securely handle asset data, semantics and processes with links to geospatial and other external data.

Further information

Technical Secretariat(s)	SN
CCMC Programme Manager	Hernalsteen Laurens
Business Plan	
Activity sector	Building Design

EN ISO 19650 series

EN ISO 19650-1:2018 (WI=00442004) Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 1: Concepts and principles (ISO 19650-1:2018)	2018-12-19
EN ISO 19650-2:2018 (WI=00442005) Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 2: Delivery phase of the assets (ISO 19650-2:2018)	2018-12-19
EN ISO 19650-3:2020 (WI=00442020) Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 3: Operational phase of the assets (ISO 19650-3:2020)	2020-08-19
EN ISO 19650-4:2022 (WI=00442028) Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 4: Information exchange (ISO 19650-4:2022)	2022-09-14
EN ISO 19650-5:2020 (WI=00442017) Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 5: Security-minded approach to information management (ISO 19650-5:2020)	2020-07-01
EN ISO 19650-6:2025 (WI=00442036) Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 6: Health and safety information (ISO 19650-6:2025)	2025-01-22

ISO → EN-ISO

EN ISO 12006-2:2020 (WI=00442026) Building construction - Organization of information about construction works - Part 2: Framework for classification (ISO 12006-2:2015)	2020-02-05
EN ISO 12006-3:2022 (WI=00442019) Building construction - Organization of information about construction works - Part 3: Framework for object-oriented information (ISO 12006-3:2022)	2022-08-03
EN ISO 16739-1:2024 (WI=00442040) Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries - Part 1: Data schema (ISO 16739-1:2024)	2024-04-03
EN ISO 16757-1:2019 (WI=00442012) Data structures for electronic product catalogues for building services - Part 1: Concepts, architecture and model (ISO 16757-1:2015)	2019-05-29
EN ISO 16757-2:2019 (WI=00442013) Data structures for electronic product catalogues for building services - Part 2: Geometry (ISO 16757-2:2016)	2019-05-29
EN ISO 21597-2:2020 (WI=00442016) Information container for linked document delivery - Exchange specification - Part 2: Link types (ISO 21597-2:2020)	2020-11-18
EN ISO 22014:2024 (WI=00442041) Library objects for architecture, engineering, construction and use (ISO 22014:2024)	2024-05-08
EN ISO 23386:2020 (WI=00442007) Building information modelling and other digital processes used in construction - Methodology to describe, author and maintain properties in interconnected data dictionaries (ISO 23386:2020)	2020-03-25
EN ISO 23387:2020 (WI=00442010) Building information modelling (BIM) - Data templates for construction objects used in the life cycle of built assets - Concepts and principles (ISO 23387:2020)	2020-07-22
EN ISO 29481-1:2017 (WI=00442006) Building information models - Information delivery manual - Part 1: Methodology and format (ISO 29481-1:2016)	2017-10-11
EN ISO 29481-2:2016 (WI=00442001) Building information models - Information delivery manual - Part 2: Interaction framework (ISO 29481-2:2012)	2016-10-19
EN ISO 29481-3:2022 (WI=00442034) Building information models - Information delivery manual - Part 3: Data schema (ISO 29481-3:2022)	2022-10-12
EN ISO 7817-1:2024 (WI=00442046) Building Information Modelling - Level of Information Need - Part 1 Concepts and principles (ISO 7817-1:2024)	2024-07-03

More standards/recommmendations CEN

Project reference, Title	Publication date
CEN/TR 17439:2020 (WI=00442022) Guidance on how to implement EN ISO 19650-1 and -2 in Europe	2020-06-10
CEN/TR 17654:2021 (WI=00442024) Guideline for the implementation of Exchange Information Requirements (EIR) and BIM Execution Plans (BEP) on European level based on EN ISO 19650-1 and -2	2021-07-14
CEN/TR 17741:2021 (WI=00442023) Guidance for understanding and utilize EN/ISO 29481-1 Building information models - Information delivery manual - Part 1: Methodology and format	2021-12-22
CEN/TR 17920:2023 (WI=00442027) BIM in infrastructure - Standardization need and recommendations	2023-02-08
CEN/TR 18077:2024 (WI=00442049) Building information modelling - Digital twins applied to the built environment - Use cases	2024-09-04
CEN/TR 18093:2024 (WI=00442031) Framework and Implementation of Common Data Environment solutions and workflow, in accordance with EN ISO 19650	2024-09-18
CEN/TS 18113:2024 (WI=00442050) Guidance on how to implement EN ISO 19650-series in Europe, in particular parts 1, 2, 3, 4 and 5.	2024-12-18
EN 17549-2:2023 (WI=00442033) Building information modelling - Information structure based on EN ISO 16739 1 to exchange data templates and data sheets for construction objects - Part 2: Configurable construction objects and requirements	2023-05-03
EN 17632-1:2022 (WI=00442021) Building information modelling (BIM) - Semantic modelling and linking (SML) - Part 1: Generic modelling patterns	2022-12-07
EN 17632-2:2024 (WI=00442042) Building information modelling (BIM) - Semantic modelling and linking (SML) - Part 2: Domain-specific modelling patterns	2024-11-13

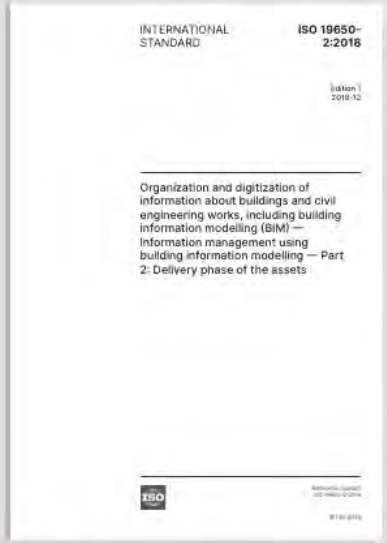
In progress

Project reference	Status	Initial Date	Current Stage	Next Stage	Forecasted voting date
FprCEN/TS XXX (WI=00442051) Building information modelling - Methodology to enable design and product standards to support digitalization through using standards developed by CEN/TC 442	Under Drafting	2023-11-24	2024-05-31	2026-08-31	
prCEN ISO/TS 23143-4 (WI=00442065) Information exchange between BIM and GIS — Part 4: Aligning geometrical representation	Under Drafting	2024-10-28	2024-10-28	2025-04-28	
prCEN ISO/TS 25055 (WI=00442056) Compatibility policy for EN ISO 16739-1 revisions	Under Drafting	2024-04-10	2024-04-10	2024-10-10	
prCEN ISO/TS 7817-2 (WI=00442057) Building Information Modelling – Level of information need – Part 2: Guidance for application	Under Drafting	2024-05-13	2024-05-13	2024-11-13	
prEN 18162 (WI=00442055) Building Information Modelling (BIM) - Digital twins applied to the built environment - Concept and definitions	Under Enquiry	2024-04-04	2025-02-06	2025-05-01	2026-01-15
prEN ISO 12006-2 (WI=00442047) Building construction - Organization of information about construction works - Part 2: Framework for classification and breakdown structures (ISO/DIS 12006-2:2024)	Under Approval	2022-10-31	2025-03-04	2025-11-04	2025-11-04
prEN ISO 16757-4 (WI=00442045) Data structures for electronic product catalogues for building services - Part 4: Dictionary structures for product catalogue (ISO/DIS 16757-4:2024)	Under Approval	2022-08-05	2025-03-20	2025-05-30	2025-03-20
prEN ISO 16757-5 (WI=00442044) Data structures for electronic product catalogues for building services - Part 5: Product catalogue exchange format (ISO/DIS 16757-5:2024)	Under Approval	2022-08-05	2025-03-17	2025-05-26	2025-03-17
prEN ISO 19650-1 rev (WI=00442066) Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling — Part 1: Concepts and principles	Under Drafting	2024-11-05	2024-11-05	2025-05-05	2026-12-15
prEN ISO 19650-2 rev (WI=00442067) Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling — Part 2: : Information management process	Under Drafting	2024-11-05	2024-11-05	2025-05-05	2026-12-15

Further deepening on this and other matters



Link



Read sample

ISO 19650-2:2018

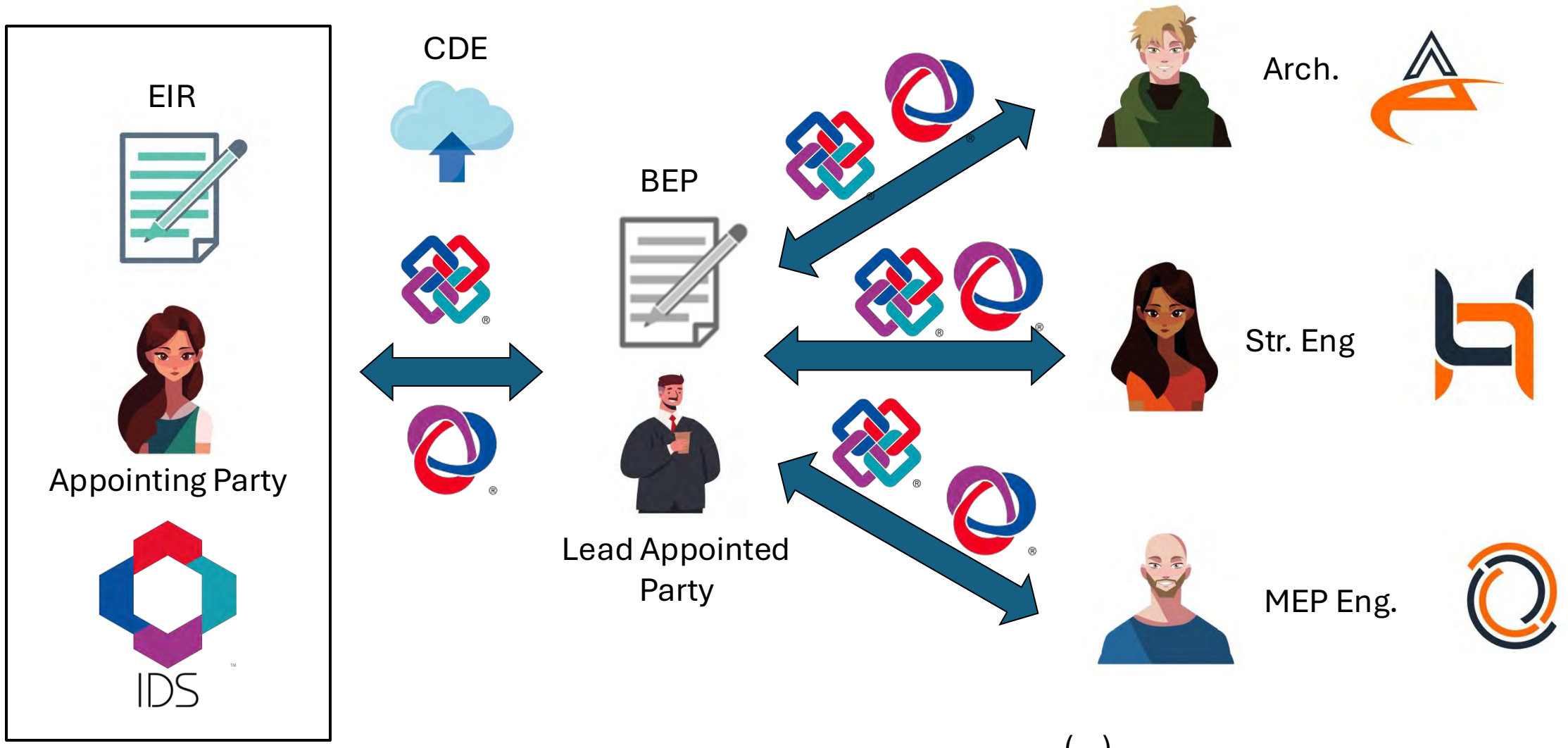
Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling

Part 2: Delivery phase of the assets

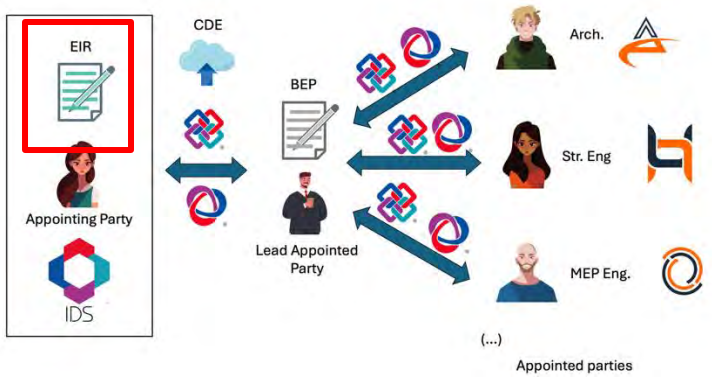
Published (Edition 1, 2018)

This publication was last reviewed and confirmed in 2024. Therefore this version remains current.

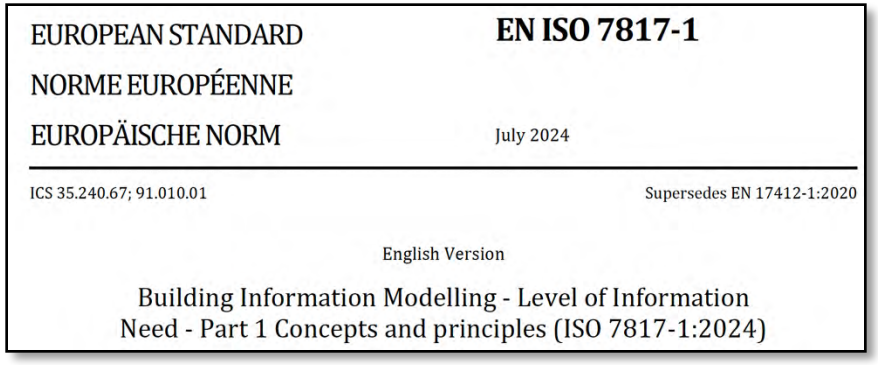
Typical workflow according to EN19650-2 (an example)



Exchange Information Requirements



"5.5 Exchange information requirements (EIR)
EIR set out managerial, commercial and technical aspects of producing project information…. " (19650-1)



EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN ISO 7817-1

July 2024

ICS 35.240.67; 91.010.01

Supersedes EN 17412-1:2020

English Version

Building Information Modelling - Level of Information Need - Part 1 Concepts and principles (ISO 7817-1:2024)

EIR inclui (ISO 19650-2):

- Information Requirements
- Level of Information Need
- Information production standard; Information production methods and procedures
- Reference and support information
- Delivery milestones


CHEK
DIGITAL BUILDING PERMIT

DIGITAL BUILDING PERMIT

Exchange Information Requirements

CHEK Summer Course

Miguel Azenha, José Granja, Bruno Muniz

ISISE, University of Minho, PORTUGAL

Funded by
the European Union

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2.4 Important aspects of the EIR

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3. buildingSMART Portugal EIR example

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3.2 Specific details of the buildingSMART Portugal EIR

4. EIR in the DBP context

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4.2 CHEK EIR example

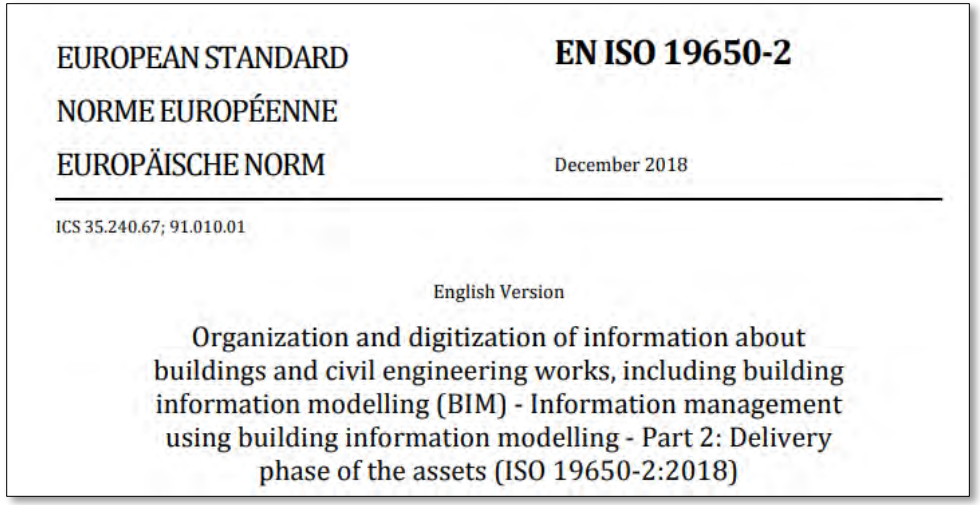
4.3 Specific details of the CHEK EIR

1. EN ISO 19650-2

1.1 Definition

"0.1 Purpose

This document is designed to enable an appointing party to establish their requirements for information during the delivery phase of the assets and to provide the right commercial and collaborative environment within which (multiple) appointed parties can produce information in an effective and efficient manner." (EN ISO 19650-2)



EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN ISO 19650-2

December 2018

ICS 35.240.67; 91.010.01

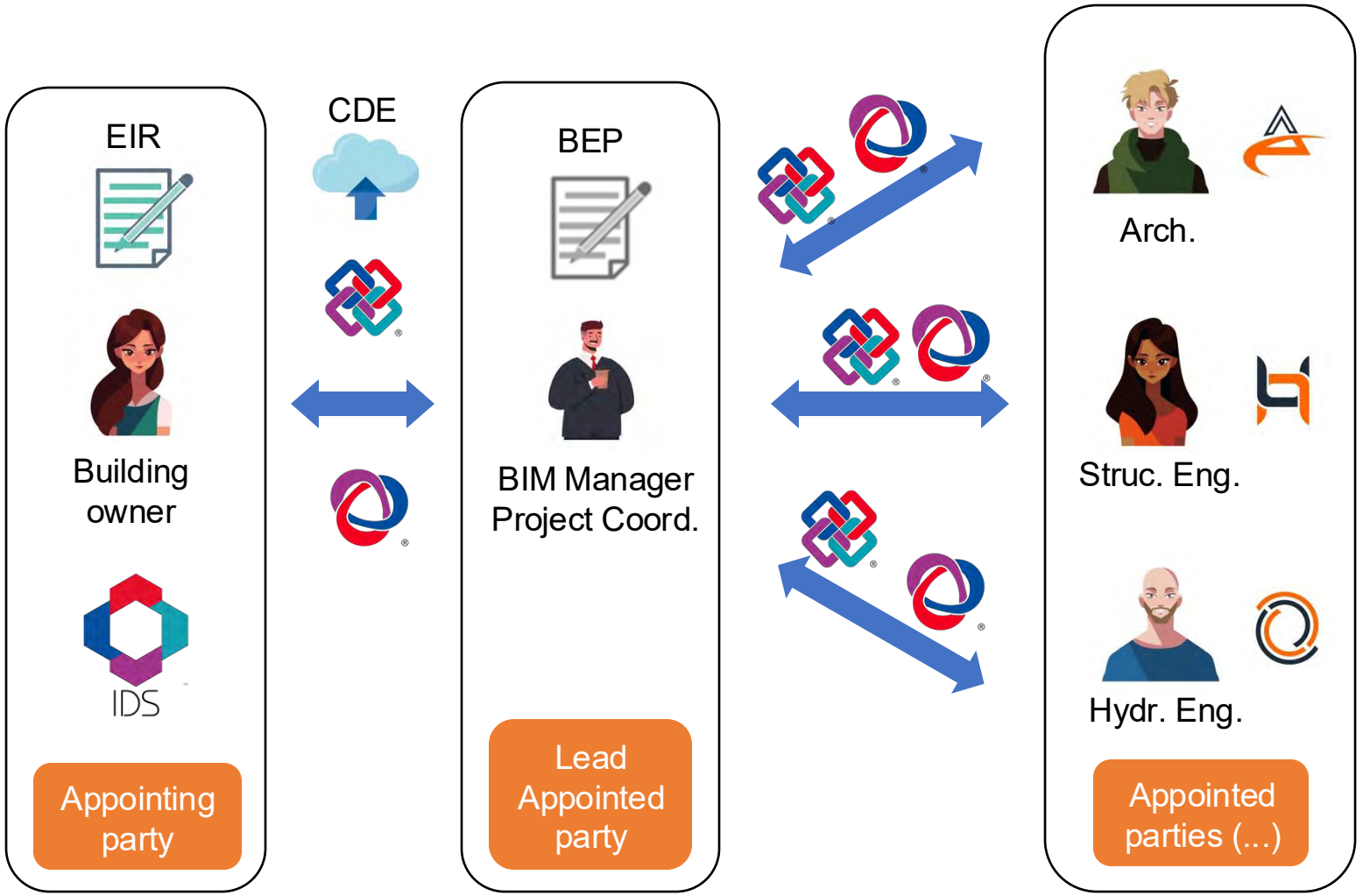
English Version

Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 2: Delivery phase of the assets (ISO 19650-2:2018)

Some notes / clarifications

- In many cases, the appointing party is the "owner/client"
- The "delivery phase of the assets" corresponds to the stages of design and construction
- This standard sets several rules for procurement, production and approval of information
- Usual tools in the process are the EIR "Exchange Information Requirements" and the BEP "BIM Execution Plan"

1.2 Information Management



Let’s now explain the concept of the EIR…



2. Exchange Information Requirements (EIR)

2.1 Definition

"5.5 Exchange information requirements (EIR)

EIR set out managerial, commercial and technical aspects of producing project information. The managerial and commercial aspects should include the information standard and the production methods and procedures to be implemented by the delivery team." (EN ISO 19650-1)



2.2 EN ISO 19650-2

"5.2 Information management process - Invitation to tender

5.2.1 Establish the appointing party's exchange information requirements

[...] the appointing party shall:

***a)** establish the appointing party's **information requirements** to be served during the appointment […]*

***b)** establish the **level of information need** required to meet each information requirement;*

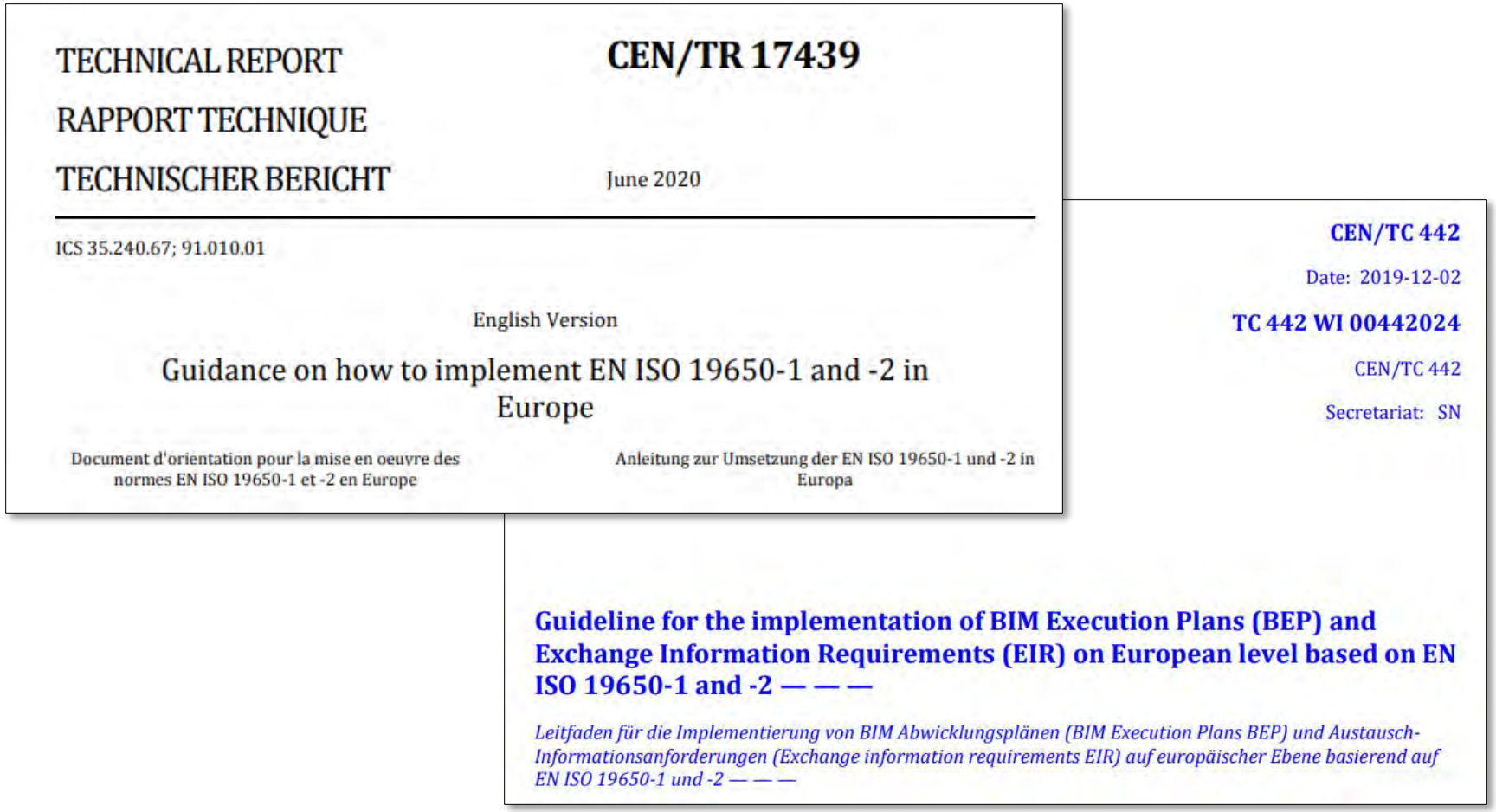
***c)** establish the **acceptance criteria** for each information requirement […]*

***d)** establish the **supporting information** that the prospective lead appointed party might need, to fully understand or evaluate each information requirement or its acceptance criteria […]*

***e)** establish the dates, relative to the project's **information delivery milestones** and appointing party's key decision points, that each requirement has to be met […]" (EN ISO 19650-2)*

2. Exchange Information Requirements (EIR)

2.3 Further guidances on how to prepare the EIR



TECHNICAL REPORT
RAPPORT TECHNIQUE
TECHNISCHER BERICHT

CEN/TR 17439

June 2020

ICS 35.240.67; 91.010.01

English Version

Guidance on how to implement EN ISO 19650-1 and -2 in Europe

Document d'orientation pour la mise en oeuvre des normes EN ISO 19650-1 et -2 en Europe

Anleitung zur Umsetzung der EN ISO 19650-1 und -2 in Europa

CEN/TC 442

Date: 2019-12-02

TC 442 WI 00442024

CEN/TC 442

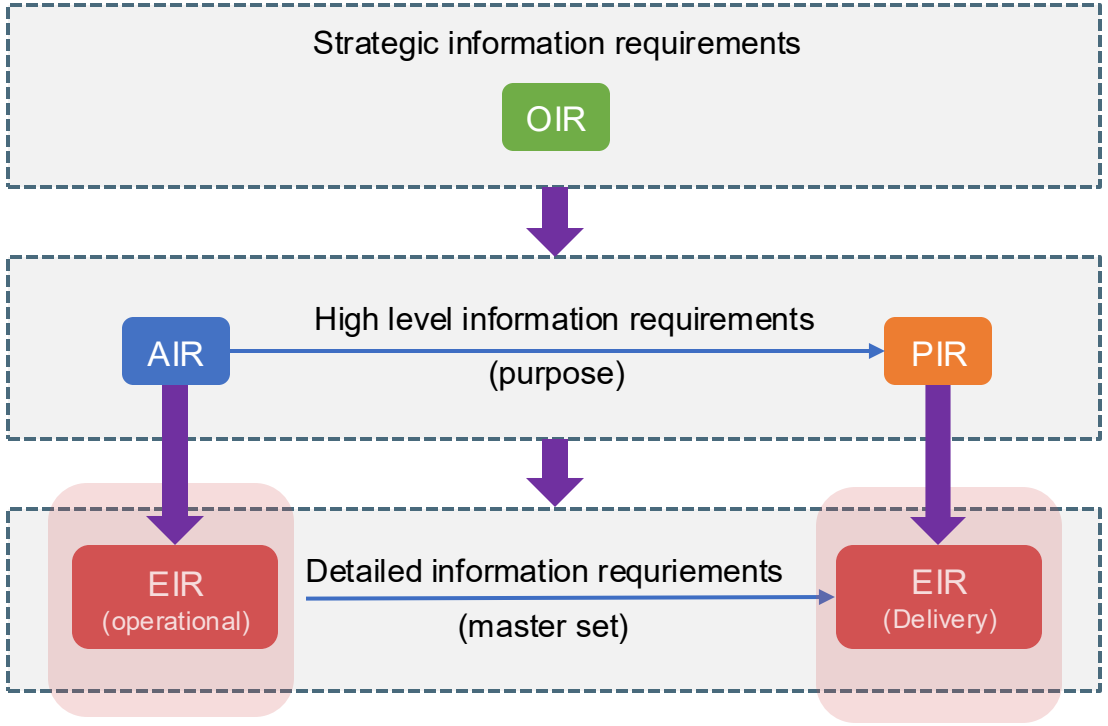
Secretariat: SN

Guideline for the implementation of BIM Execution Plans (BEP) and Exchange Information Requirements (EIR) on European level based on EN ISO 19650-1 and -2 — — —

Leitfaden für die Implementierung von BIM Abwicklungsplänen (BIM Execution Plans BEP) und Austausch-Informationsanforderungen (Exchange information requirements EIR) auf europäischer Ebene basierend auf EN ISO 19650-1 und -2 — — —

2.4 Important aspects of the EIR

- Usually created by the appointing party based on PIR and AIR.
- Shall be developed every time there is an appointment (e.g. between an architectural office and engineering office). Not only made by the client.
- EIR normally alligned with trigger events / project stages.
- A project can have many appointments with all EIR's forming a single coherent and coordinated set of Information requirements, adequate to the PIR.



Adapted from UK BIM Framework (2025)

2.5 Level of Information Need

Definition

"6.1 General

The level of information need is the framework which defines the extent and granularity of information to be exchanged. In accordance with this standard the level of information need should be described by different concepts: ***geometrical information****,* ***alphanumerical information*** *and* ***documentation****." (EN ISO 7817-1)*

Level of Information Need		
How		
Geometrical Information	Detail	Simplified volume representation including openings
	Dimensionality	3D
	Location	Absolute
	Appearance	Realistic with texture of materials
	Parametric behaviour	Not requested
Alphanumerical Information	Identification	Wall type
	Information content	Type, ...
Documentation	Set of documents	Not requested

Level of Information Need example - Adapted from EN ISO 7817-1 (2025)

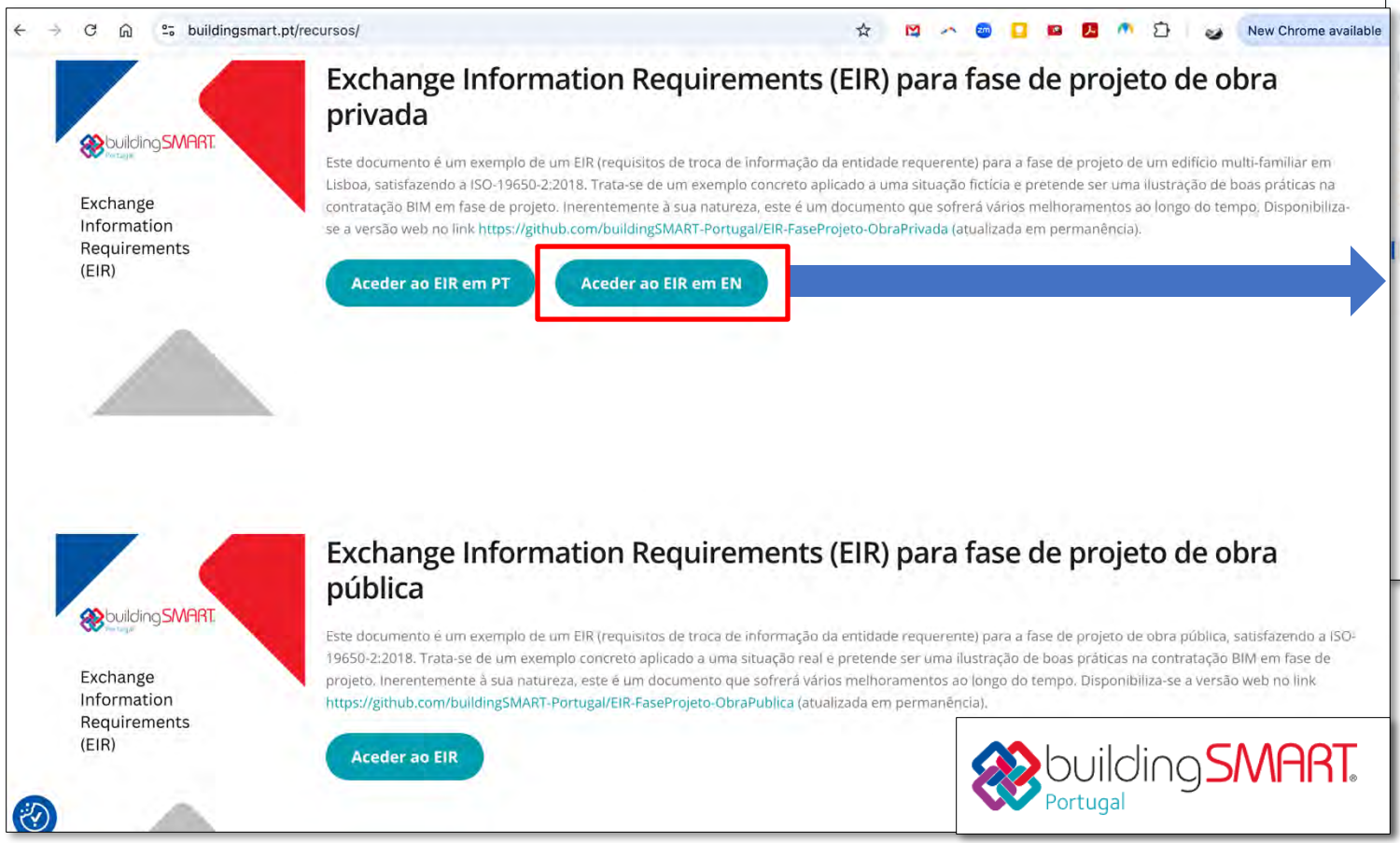
Let’s now present the buildingSMART Portugal EIR example…

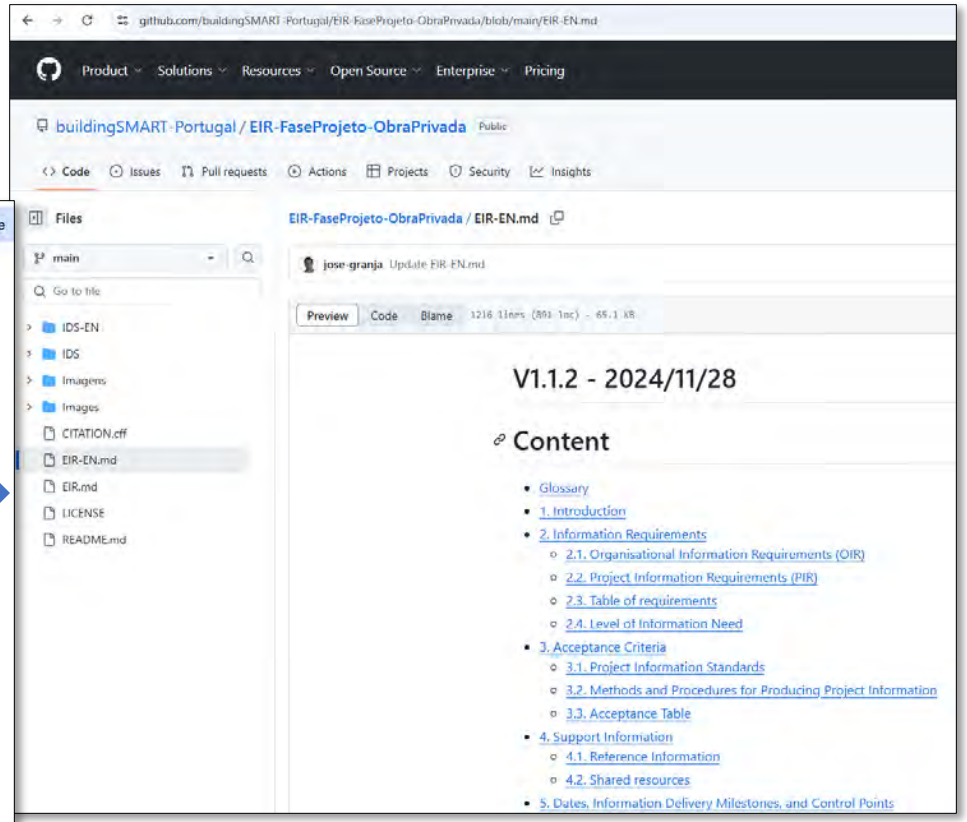


3. buildingSMART Portugal EIR example

Example (buildingSMART Portugal)

[buildingSMART EIR]





This EIR example has been created in the following context:

- A 5-storey multi-family building
- Located in Lisbon
- Private owner
- Design phase
- Complying with EN ISO 19650-2 (2018)

3. buildingSMART Portugal EIR example

3.1 EIR table of contents according to EN ISO 19650-2

EN ISO 19650-2

"5.2 Information management process - Invitation to tender

5.2.1 Establish the appointing party's exchange information requirements

The appointing party shall establish their exchange information requirements to be met by the prospective lead appointed party during the appointment. In doing this, the appointing party shall:

***a)** establish the appointing party's **information requirements** to be served during the appointment, and in doing so shall consider their:*

— organizational information requirements,

— asset information requirements, and

— project information requirements;

***b)** establish the **level of information need** required to meet each information requirement;*

NOTE Other metrics to describe the status of information, such as level of accuracy, can be added to these metrics as considered appropriate."

buildingSMART Portugal EIR



3. buildingSMART Portugal EIR example

3.1 EIR table of contents according to EN ISO 19650-2

EN ISO 19650-2

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***c)** establish the **acceptance criteria** for each information requirement, and in doing so shall consider:*

*— the **project's information standard**,*

*— the **project's information production methods and procedures**, and…"*

buildingSMART Portugal EIR



3. buildingSMART Portugal EIR example

3.1 EIR table of contents according to EN ISO 19650-2

EN ISO 19650-2

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The appointing party shall establish their exchange information requirements to be met by the prospective lead appointed party during the appointment. In doing this, the appointing party shall:

***c)** establish the **acceptance criteria** for each information requirement, and in doing so shall consider:*

*— the **project's information standard**,*

*— the **project's information production methods and procedures**, and*

*— the use of **reference information or shared resources** provided by the appointing party;*

***d)** establish the **supporting information** that the prospective lead appointed party might need, to fully understand or evaluate each information requirement or its acceptance criteria, and in doing so shall consider:*

— existing asset information,

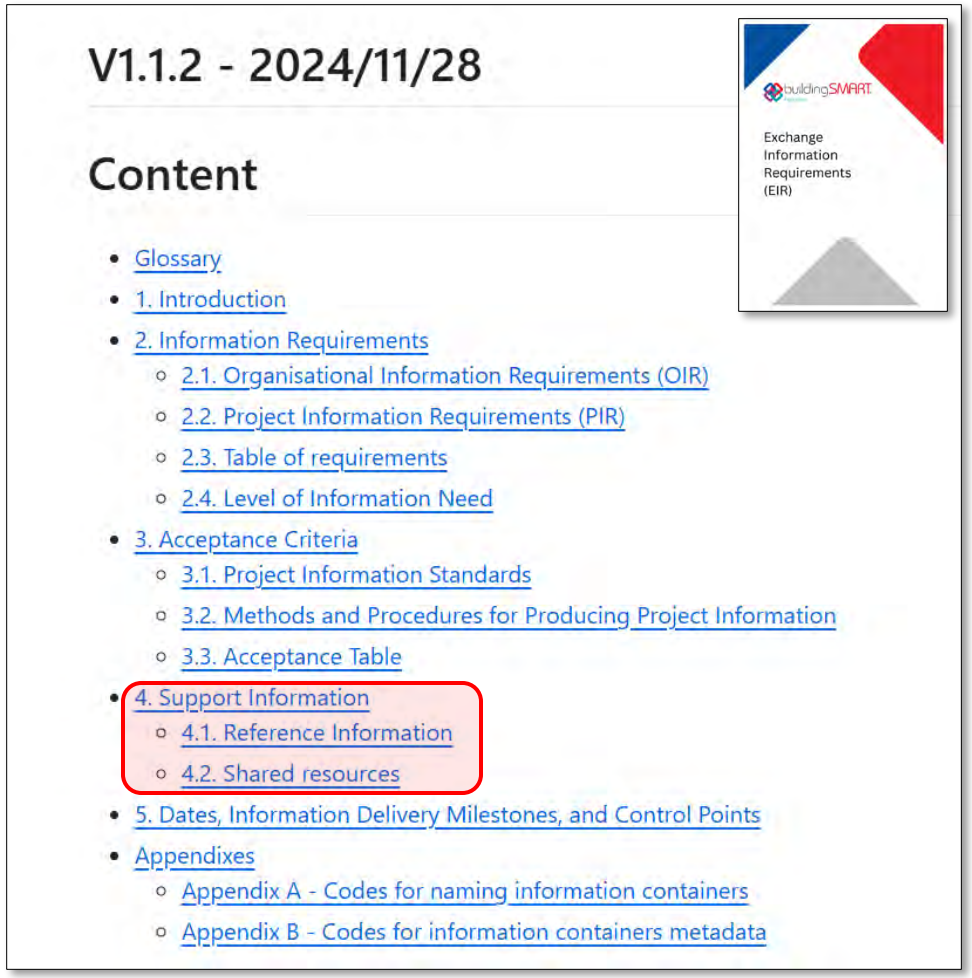
— shared resources,

— supporting documents or guidance material,

— references to relevant international, national or industry standards, and

— exemplars of similar information deliverables;"

buildingSMART Portugal EIR



3.1 EIR table of contents according to EN ISO 19650-2

EN ISO 19650-2

"5.2 Information management process - Invitation to tender

5.2.1 Establish the appointing party's exchange information requirements

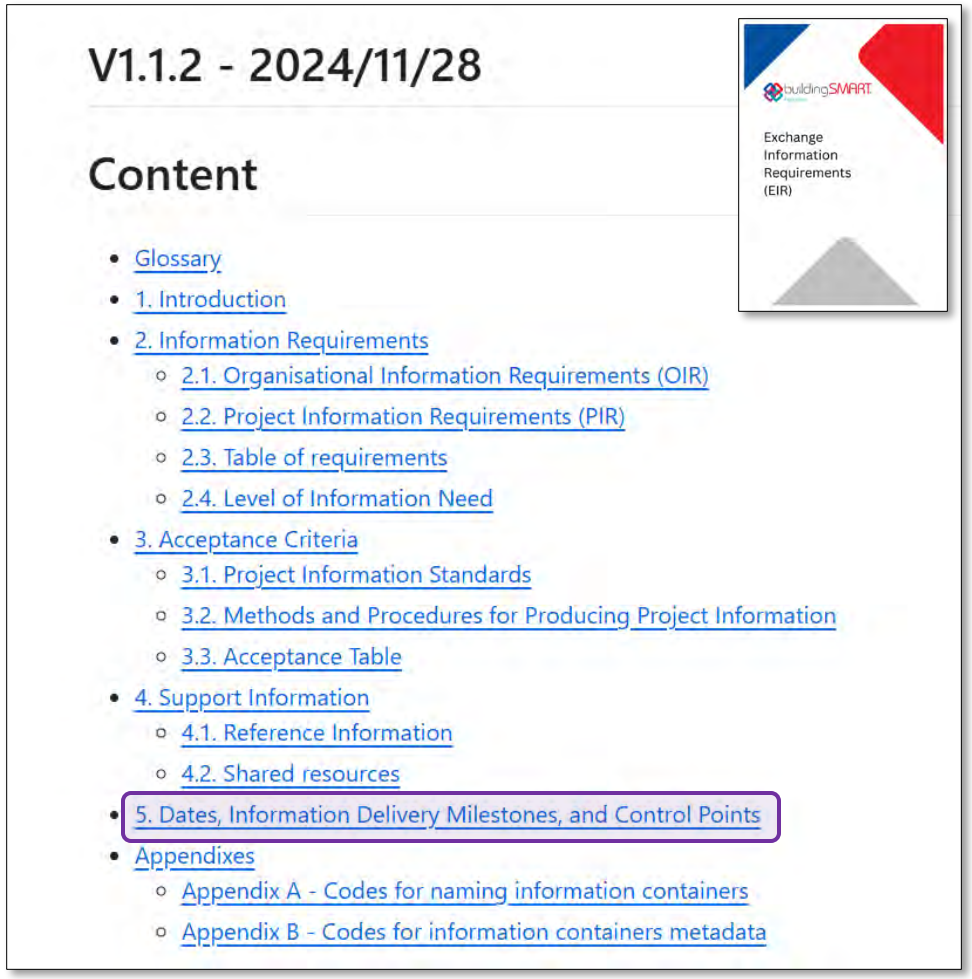
The appointing party shall establish their exchange information requirements to be met by the prospective lead appointed party during the appointment. In doing this, the appointing party shall:

***e)** establish the dates, relative to the project's **information delivery milestones** and appointing party's key decision points, that each requirement has to be met, and in doing so shall consider:*

— the time needed by the appointing party to review and accept information, and

— the appointing party's internal assurance processes."

buildingSMART Portugal EIR



3. buildingSMART Portugal EIR example

Let’s now delve deeper in the buildingSMART Portugal EIR…



3.2 Specific details of the buildingSMART Portugal EIR

2. Information requirements

- ✓ **2.1 Organizational Information Requirements (OIR)**
- ✓ **2.2 Project Information Requirements (PIR)**
  - ✓ **2.2.1 Appointing Party**
  - ✓ **2.2.2 Commercial name of the project**
  - ✓ **2.2.3 Project scope**
  - ✓ **2.2.4 Purposes for which the information will be used by the Appointing Party**
  - 2.2.5 Phases
  - 2.2.6 Hiring process
  - 2.2.7 Key decision points
  - 2.2.8 Decisions that will be taken at each key decision point.
  - 2.2.9 Questions that need to be answered for informed decision-making. (PLQ)
- 2.3 Table of requirements
- 2.4 Level of Information Need

2.1. Organisational Information Requirements (OIR)

The OIR is in line with the company's ESG (Environmental Social and Governance) policies. The following aspects stand out:

- Developing properties that have the least impact on the environment and on the safety and health of the surrounding community and future property users.
- Construction of properties that comply with national regulations and incorporate sustainable solutions, including sustainability certification.

2.2. Project Information Requirements (PIR)

2.2.1. Appointing Party

`buildingSMART Portugal`

2.2.2. Commercial name of the project

`Open BIM Gardens`

2.2.3. Project scope

Building for mixed use (multi-family housing and commerce) with 5 floors above ground and 2 floors below ground. Purpose of marketing and sale of all fractions.

2.2.4. Purposes for which the information will be used by the Appointing Party

- **PIR01**: `Regulatory compliance` :
  - Development of all the necessary elements for permiting the development with the municipal authorities. All the written and drawn documents for the permiting procedure.
- **PIR02**: `Sustainability` :
  - Development of a specific sustainability study for BREEAM 'Very Good' certification.

3.2 Specific details of the buildingSMART Portugal EIR

2. Information requirements

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- 2.3 Table of requirements
- 2.4 Level of Information Need

2.2.5. Phases

- **Phase 01:** `Preliminary Design` - 01 Mar 2024 - 31 May 2024.
- **Phase 02:** `Developed Design` - 01 Jun 2024 - 31 Aug 2024.
- **Phase 03:** `Technical Design` - 4 months after permiting approval.

2.2.6. Hiring process

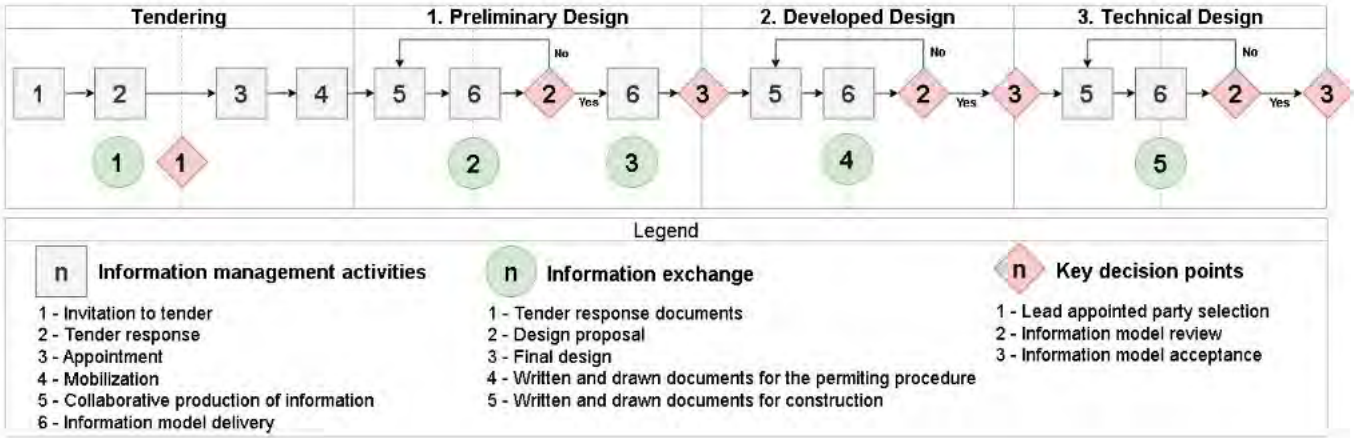
Direct award after initial consultation by invitation.

2.2.7. Key decision points

When defining information delivery milestones and key decision points, the time needed to review and accept the information is taken into account.

The points to consider are identified below.

The key decision points are scheduled for 10 working days after the exchanges of information with the Appointing Party and are distributed throughout the phases.



3.2 Specific details of the buildingSMART Portugal EIR

2. Information requirements

- ✓ 2.1 Organizational Information Requirements (OIR)
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  - ✓ 2.2.6 Hiring process
  - ✓ 2.2.7 Key decision points
  - ✓ **2.2.8 Decisions that will be taken at each key decision point.**
  - ✓ **2.2.9 Questions that need to be answered for informed decision-making. (PLQ)**
- 2.3 Table of requirements
- 2.4 Level of Information Need

2.2.8. Decisions that will be taken at each key decision point.

- **Key decision point 1**
  - Decision to award a contract
- **Key decision point 2**
  - Decision on the level of BREEAM certification that is really desired, taking into account performance objectives and budgetary limits.
  - Decision on investment continuity and possible adaptations to strategic objectives.

2.2.9. Questions that need to be answered for informed decision-making. (PLQ)

- **Key decision point 1**
  - Is the fee proposal considered adequate?
  - Does the company/consortium of companies have a portfolio, team and capacity for the work?
  - In the BIM field, does it adequately fulfil the assessment using the matrix ('Formulário de apoio à avaliação de candidatos') of the CT197 'Guia de Contratação'?
- **Key decision point 2**
  - Are the requirements of the construction budget and the project met?
  - Are the architectural and technical solutions appropriate and do they satisfy preferences?
  - Does the BREEAM certification fulfil the criteria in a financially reasonable way?

3. buildingSMART Portugal EIR example

3.2 Specific details of the buildingSMART Portugal EIR

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  - ✓ 2.2.9 Questions that need to be answered for informed decision-making. (PLQ)
- ✓ **2.3 Table of requirements**
- 2.4 Level of Information Need

2.3. Table of requirements

PIR Ref.	Information purpose	EIR Ref.	Exchange Information Requirement (EIR)
PIR01	Regulatory compliance	EIR01	Survey of regulatory constraints (local and national).
		EIR02	Survey of the site and its surroundings (including the topographical component and existing buildings).
		EIR03	Geological-geotechnical study of the building site.
		EIR04	Modelling of Architecture, Structural Design, Water Supply Networks, Wastewater and Rainwater Drainage Networks, HVAC, gas, fire, electrical*, telecommunications* and other disciplines required for the design in question, with the appropriate geo-referencing. Provision of a federation of models by the Lead Appointed Party. * the models in question will be represented in simplified form according to the level of information need.
		EIR05	Model coordination resulting from the combined analysis of architecture and disciplines. Support coordination in the collision matrix for which the Lead Appointed Party is responsible.
		EIR06	Monitoring and validation of the BIM coordination process. Evidence of this process should be provided by the Lead Appointed Party's information manager. This evidence should demonstrate that the project is being developed in accordance with regulations and with the agreement of the Appointing Party, and that existing conflicts in the models are resolved.
		EIR07	Production of drawings (obtained from the models, with potential exclusions duly justified in the BEP) and technical documentation from architectural and other disciplines designs.
		EIR08	Energy simulations and certification.
PIR02	Sustainability	EIR09	BREEAM sustainability analysis with a 'Very Good' rating. The analysis does not need to be entirely based on models.

3.2 Specific details of the buildingSMART Portugal EIR

2. Information requirements

- ✓ 2.1 Organizational Information Requirements (OIR)
- ✓ 2.2 Project Information Requirements (PIR)
  - ✓ 2.2.1 Appointing Party
  - ✓ 2.2.2 Commercial name of the project
  - ✓ 2.2.3 Project scope
  - ✓ 2.2.4 Purposes for which the information will be used by the Appointing Party
  - ✓ 2.2.5 Phases
  - ✓ 2.2.6 Hiring process
  - ✓ 2.2.7 Key decision points
  - ✓ 2.2.8 Decisions that will be taken at each key decision point.
  - ✓ 2.2.9 Questions that need to be answered for informed decision-making. (PLQ)
- ✓ 2.3 Table of requirements
- ✓ **2.4 Level of Information Need**

2.4. Level of Information Need

The development of the tables with the Level of Information Need (EN ISO 7817-1:2024) to be followed in the various exchanges of information between the different actors is the responsibility of the Lead Appointed Party. The tables must be contained in the BEP, and this document presents reference tables with minimum requirements. Apoted Parties must add alphanumeric information that has not been provided for in the aforementioned tables and that is relevant to characterising the project objects. The IFC model must also contain information that makes it possible to relate the object to the bill of quantities.

Level of Information Need tables:

- General
- Architecture
- Structures
- MEP

Object	*Spaces*			
Appointing Party	*Building Owner*			
Apointed Party	*Architect*			
		PROJECT PHASE / DELIVERY MILESTONE:		
		Preliminary Design	***Developed Design***	***Technical Design***
Purpose		*Analysing the conceptual solution* *Generating drawings* *Visualization / Rendering*	*Generate drawings* *Visualization / Rendering* *Obtaining licences, permits and authorizations for the execution of the asset* *3D coordination*	*Generate drawings* *Visualization / Rendering* *3D coordination* *Quantity extraction and quotation*
EIR reference		*EIR 01, EIR 04, EIR 05, EIR 07 e EIR 10*	*EIR 01, EIR 04, EIR 05, EIR 06, EIR 07, EIR 09 e EIR 10*	*EIR 04, EIR 05, EIR 06, EIR 07, EIR 09, EIR 10, EIR 11 e EIR 12*
Minimum geometric information requirements				
Detail		*Size, geometry and orientation already defined. The external dimensions are correctly defined.*	*Dimensions are correctly defined. Connections, links and the representation of any regions that may have an impact on coordination with other systems.*	*The dimensions of the element are correctly defined. Connections, links and the representation of any regions that may have an impact on coordination with other systems.*
Dimensionality		*3D*	*3D*	*3D*
Location		*Relative*	*Relative*	*Relative*
Appearance		*Not requested*	*Not requested*	*Not requested*
Parametric behaviour		*Not requested*	*Not requested*	*Not requested*
Minimum alphanumeric information requirements				
IFC class		*IfcSpace*	*IfcSpace*	*IfcSpace*
Attributes				
Name		*X*	*X*	*X*
Predefined Type		*X*	*X*	*X*
Property sets				
Property	**Property set**			
NetFloorArea	*Qto_SpaceBaseQuantities*	*X*	*X*	*X*
Classification				
System	**Table**			
SECClasS	*Spaces/locations*	*X*	*X*	*X*

3. buildingSMART Portugal EIR example

3.2 Specific details of the buildingSMART Portugal EIR

3. Acceptance criteria

- ✓ **3.1 Project information standards**
  - ✓ **3.1.1 Standards**
  - ✓ **3.1.2. Nomenclature of information containers – Files**
  - ✓ **3.1.3 Metadata of information containers – Files**
  - 3.1.4 Nomenclature of information blocks - IFC: Objects and alphanumeric information
  - 3.1.5 Units system
  - 3.1.6 Coordinate system
  - 3.1.7 Information classification
  - 3.1.8 Format and size of information containers
  - 3.1.9 Software - Appointed Parties
  - 3.1.10 Platforms and software of the Appointing Party
  - 3.1.11 Information for the asset management operational phase
- 3.2 Methods and procedures for producing project information
  - 3.2.1 Capturing information from existing assets
  - 3.2.2 Creation, revision and approval of new information
  - 3.2.3 Delivery of information to the Appointing Party
  - 3.2.4 Security
- 3.3 Acceptance table
  - 3.3.1 Overall assessment
  - 3.3.2 Model Quality

3.1. Project information standards

Project information standards aim to describe the criteria that will provide support and consistency for the information that will be developed throughout the project. According to clause 5.1.4 of EN ISO 19650-2, their definition must take into account how information will be exchanged, the structure and classification of the information, the method used to specify the Level of Information Need and the use of the information in post-construction phases and for operating the asset.

3.1.1. Standards

`EN ISO 19650 standard series and EN ISO 7817-1:2024 standard`

3.1.2. Nomenclature of information containers - Files

Information containers must be named using eight fields, separated by a delimiter, according to the following convention:

`<Project>` - `<Originator>` - `<Volume/System>` - `<Level/Location>` - `<Type>` - `<Discipline>` - `<Phase>` - `<Number>`

a) Project

Unique code representing the project.

> Code:
> `OBG`

3.1.3. Metadata of information containers - Files

Metadata are additional attributes to the information containers that make it easier to locate, use and manage.

Information containers must contain metadata, separated by a delimiter, according to the following convention:

`<Status>` - `<Revision>` - `<Classification>` - `<Description>` - `<Date>` - `<Others>`

3. buildingSMART Portugal EIR example

3.2 Specific details of the buildingSMART Portugal EIR

3. Acceptance criteria

- ✓ 3.1 Project information standards
  - ✓ 3.1.1 Standards
  - ✓ 3.1.2. Nomenclature of information containers – Files
  - ✓ 3.1.3 Metadata of information containers – Files
  - ✓ **3.1.4 Nomenclature of information blocks - IFC: Objects and alphanumeric information**
  - ✓ **3.1.5 Units system**
  - ✓ **3.1.6 Coordinate system**
  - ✓ **3.1.7 Information classification**
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  - 3.1.9 Software - Appointed Parties
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- 3.2 Methods and procedures for producing project information
  - 3.2.1 Capturing information from existing assets
  - 3.2.2 Creation, revision and approval of new information
  - 3.2.3 Delivery of information to the Appointing Party
  - 3.2.4 Security
- 3.3 Acceptance table
  - 3.3.1 Overall assessment
  - 3.3.2 Model Quality

3.1.4. Nomenclature of information blocks - IFC: Objects and alphanumeric information

It is not prescribed. However, it is recommended to use the nomenclatures in the proposed technical specification for 'Regras de modelação de objetos' available at: https://bit.ly/secclass_manual_objetos_bim_. The Lead Appointed Party must explain the principles adopted for naming in the BEP.

3.1.5. Units system

`International System of Units` in coherence with Directive 80/181/EEC and its addenda. EN ISO 80000-1:2022. The monetary unit is `€`.

3.1.6. Coordinate system

The coordinate system `PT-TM06/ETRS89` (EPSG: 3763) will be used, following DGT specifications.

https://www.dgterritorio.gov.pt/geodesia/sistemas-referencia/portugal-continental/PT-TM06-ETRS89

3.1.7. Information classification

Classification system `SECClasS` in the version in force on the date of issue of this document.

https://secclass.pt/pesquisa/

3.1.8. Format and size of information containers

Editable documents and spreadsheets following the ISO/IEC 29500-1:2016 standard (XLSX and DOCX formats are valid, for example).

Point cloud survey files in ASTM E57.

3. buildingSMART Portugal EIR example

3.2 Specific details of the buildingSMART Portugal EIR

3. Acceptance criteria

- 3.1 Project information standards
  - 3.1.1 Standards
  - 3.1.2. Nomenclature of information containers – Files
  - 3.1.3 Metadata of information containers – Files
  - 3.1.4 Nomenclature of information blocks - IFC: Objects and alphanumeric information
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  - **3.1.9 Software - Appointed Parties**
  - **3.1.10 Platforms and software of the Appointing Party**
  - **3.1.11 Information for the asset management operational phase**
- **3.2 Methods and procedures for producing project information**
  - **3.2.1 Capturing information from existing assets**
  - 3.2.2 Creation, revision and approval of new information
  - 3.2.3 Delivery of information to the Appointing Party
  - 3.2.4 Security
- 3.3 Acceptance table
  - 3.3.1 Overall assessment
  - 3.3.2 Model Quality

3.1.9. Software - Appointed Parties

There are no requirements for the software to be used by the Appointed Parties. The software to be used will be validated at the BEP approval stage.

3.1.10. Platforms and software of the Appointing Party

The Appointing Party will use the software `<IFCVualisation/VerificationSoftwareName>` to visualise, verify and validate information containers IFC. The Lead Appointed Party must verify the proper performance of the information containers IFC on this platform and inform beforehand of potential problems in the interpretation of the IFCs submitted.

The CDE to be used will be maintained on the Appointing Party's servers and will consist of the `R2U` * CDE solution.

3.1.11. Information for the asset management operational phase

No specific requirements in the design phase beyond the classification already required. This information will be required at the contract consultation stage.

3.2. Methods and procedures for producing project information

Project information production methods and procedures define the approaches and techniques that the Appointing Party uses to create, manage and approve information.

3.2.1 Capturing information from existing assets

As there has been no previous construction on the site and the updated topographical survey is available in the Reference Information (and complies with Lisbon City Council requirements), no information capture of this type is expected to be necessary.

There is a need to survey the surroundings using methods that provide sufficient information for the permiting process and for analysing shading and occlusions.

3.2 Specific details of the buildingSMART Portugal EIR

3. Acceptance criteria

- 3.1 Project information standards
  - 3.1.1 Standards
  - 3.1.2. Nomenclature of information containers – Files
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  - 3.1.8 Format and size of information containers
  - 3.1.9 Software - Appointed Parties
  - 3.1.10 Platforms and software of the Appointing Party
  - 3.1.11 Information for the asset management operational phase
- 3.2 Methods and procedures for producing project information
  - 3.2.1 Capturing information from existing assets
  - **3.2.2 Creation, revision and approval of new information**
  - 3.2.3 Delivery of information to the Appointing Party
  - 3.2.4 Security
- 3.3 Acceptance table
  - 3.3.1 Overall assessment
  - 3.3.2 Model Quality

3.2.2. Creation, revision and approval of new information

a) Information creation:

The production of native models and associated data must allow the creation of models in IFC. Proxy objects should not be used when there is a specific object class for this purpose in SCHEMA IFC.

The delivery team must define an origin for the project's local coordinate reference that is common to all models.

The local reference point may be rotated in relation to the North of the coordinate system, and this rotation must be established in the BIM Execution Plan with the corresponding justification.

The structure of the IFC models should be uniform across all disciplines, with the nomenclature complying with the following table:

IFC entity	Nomenclature
IfcProject	OpenBIMGarden
-- IfcSite	Arroios
---- IfcBuilding	OpenBIMGarden01
------ IfcBuildingStorey	S02
------ IfcBuildingStorey	S01
------ IfcBuildingStorey	P00
------ IfcBuildingStorey	P01
------ IfcBuildingStorey	P02
------ IfcBuildingStorey	P02
------ IfcBuildingStorey	P03
------ IfcBuildingStorey	P04
------ IfcBuildingStorey	C05

3.2 Specific details of the buildingSMART Portugal EIR

3. Acceptance criteria

- ✓ 3.1 Project information standards
  - ✓ 3.1.1 Standards
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  - ✓ 3.1.11 Information for the asset management operational phase
- ✓ 3.2 Methods and procedures for producing project information
  - ✓ 3.2.1 Capturing information from existing assets
  - ✓ 3.2.2 Creation, revision and approval of new information
  - ✓ **3.2.3 Delivery of information to the Appointing Party**
  - ✓ **3.2.4 Security**
  - 3.3 Acceptance table
    - 3.3.1 Overall assessment
    - 3.3.2 Model Quality



3.2.3. Delivery of information to the Appointing Party

The final deliverables will be realised using the CDE solution determined previously.

The final deliverables must move to status S5 (table B.1) when they are finalised within the dates determined in section 5.

3.2.4. Security

The collaborative digital working methods and technologies used in the project involve the collaborative sharing of information by a number of independent actors, and therefore the need arose to manage the vulnerability issues inherent in the availability of information in accordance with the requirements of EN ISO 19650-5. The Appointing Party therefore carried out a sensitivity assessment to identify whether or not a security approach was required and applied the triage process, which led to the ST4 classification.

This classification led to the conclusion that in this project there will be no need to develop a security strategy, respective security plan, fault and incident management plans and information sharing agreements with Appointed Parties. However, commercial and personal information must be protected in accordance with the legislation in force, namely the GDPR. Appropriate measures must also be taken to minimise threats arising from fraudulent and other criminal activities and cybersecurity incidents.

3. buildingSMART Portugal EIR example

3.2 Specific details of the buildingSMART Portugal EIR

3. Acceptance criteria

- 3.1 Project information standards
  - 3.1.1 Standards
  - 3.1.2. Nomenclature of information containers – Files
  - 3.1.3 Metadata of information containers – Files
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  - 3.2.2 Creation, revision and approval of new information
  - 3.2.3 Delivery of information to the Appointing Party
  - 3.2.4 Security
- **3.3 Acceptance table**
  - **3.3.1 Overall assessment**
  - 3.3.2 Model Quality

3.3. Acceptance table

Acceptance criteria*	Note	Description
Not Applicable	NA	Requirement not applicable at a given stage or for a given project
Not compliant	0	Does not fulfil BEP criteria; In some cases, such as Levels, Grids and Orientation/Coordinate System, there are no intermediate gradations: only 0 or 3 is applied.
Partially compliant	1	Most of the information blocks do not comply with the BEP; Classification is not sufficient for approval
Substantially compliant	2	Most of the information containers comply with the BEP; Classification is sufficient for conditional approval
Fully compliant	3	All information containers are in accordance with the BEP

* Minimum score for acceptance is 2; this score can be weighted according to the context, project phase or discipline and be justified in the comments.

3.3.1. Overall assessment

Ref.	EIR	Title	Description
A	EIR01	Survey of regulatory constraints	Delivery of a summary of the identified constraints. Information provided in accordance with the project's standards and information production methods and procedures.
B	EIR02	Survey of the site and its surroundings	Delivery of the point cloud. Information provided in accordance with the project's standards and information production methods and procedures.
C	EIR03	Geological-geotechnical study	Delivery of the geological-geotechnical report. Information provided in accordance with the project's standards and information production methods and procedures.
D	EIR04	Modelling	Delivery of models in the formats defined in the information standards. Information provided in accordance with the project's standards and information production methods and procedures.

3. buildingSMART Portugal EIR example

3.2 Specific details of the buildingSMART Portugal EIR

3. Acceptance criteria

- ✓ 3.1 Project information standards
  - ✓ 3.1.1 Standards
  - ✓ 3.1.2. Nomenclature of information containers – Files
  - ✓ 3.1.3 Metadata of information containers – Files
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  - ✓ 3.1.9 Software - Appointed Parties
  - ✓ 3.1.10 Platforms and software of the Appointing Party
  - ✓ 3.1.11 Information for the asset management operational phase
- ✓ 3.2 Methods and procedures for producing project information
  - ✓ 3.2.1 Capturing information from existing assets
  - ✓ 3.2.2 Creation, revision and approval of new information
  - ✓ 3.2.3 Delivery of information to the Appointing Party
  - ✓ 3.2.4 Security
- ✓ 3.3 Acceptance table
  - ✓ 3.3.1 Overall assessment
  - ✓ **3.3.2 Model Quality**

3.3.2. Model Quality

a) Geometry

Ref.	Title	Description
A	General assessment	Model
B	Origin / Coordinate System	Georeferenced coordinates and inverted prism in the file
C	Orientation	Oriented to the north
D	Structural Axes	Structural axes coordinated with the base file (IfcGrid)
E	Building floors	Coordinated levels with base file (IfcBuidlingStorey)
F	Duplicates	No duplicates
G	Minimum geometric information requirements	Detail, Dimension, Location, Appearance and Parametric Behaviour according to Level of Information Need

b) Non-graphical information

Ref.	Title	Description
H	Spaces / Areas	Each space identified as IfcSpace
I	Nomenclature of information containers - Files	Files fulfil nomenclature
J	Information containers delivered to the CDE	All files have been placed in the CDE; includes Ifc and native files
K	Units.	Unit system as defined in the BEP
L	Attributes (Ifc)	Objects mapped to the right IFC Class and Type (avoid objects classified as IfcBuildingElementProxy)
M	Properties (Ifc)	Model fulfils information requirements of the Level of Information Need
N	Materials	Materials fulfil Level of Information Need requirements
O	Classification	Objects classified according to the SECClasS system

3.2 Specific details of the buildingSMART Portugal EIR

4. Support information

- ✓ **4.1 Reference information**
- 4.2 Shared resources

4. Support information

Supporting information consists of information that is intended to be made available by the Appointing Party to the Lead Appointed Party in order to avoid redundant work and ensure that the information is developed in accordance with its standards. This enables the Lead Appointed Party to have a better understanding of what is required for the project. According to clause 5.2.1 d) of EN ISO 19650-2, supporting information can consist of existing asset information, shared resources, examples of deliverables, supporting documents, guidance material and references to international, national or industry standards.

Support information is available at: https://drive.google.com/drive/folders/1JB1Rz85srkqedVM_9hqo3ANSmihxsILz?usp=sharing

4.1. Reference information

Nomenclature	State	Revision	Classification	Date	Description
OBG-BSP-ZZ-ZZZ-CE-XXX-XX-0001.pdf	A1	C01	PM_40_50	11.01.2024	Application
OBG-BSP-ZZ-ZZZ-CE-XXX-XX-0002.pdf	A1	C01	PM_40_50_49	11.01.2024	Power of attorney
OBG-BSP-ZZ-ZZZ-CE-XXX-XX-0003.pdf	A1	C01	PM_10_20_03	11.01.2024	Term, insurance, OA declaration, topography
OBG-BSP-ZZ-ZZZ-LG-XXX-XX-0001.pdf	A1	C01	PM_30_10_80	11.01.2024	Urban Land Registry
OBG-BSP-ZZ-ZZZ-LG-XXX-XX-0002.pdf	A1	C01	PM_55	11.01.2024	CRC
OBG-BSP-ZZ-ZZZ-LG-XXX-XX-0003.pdf	A1	C01	PM_30_10_47	11.01.2024	CRP
OBG-BSP-ZZ-ZZZ-LV-LEV-XX-0001.dwf	A1	C01	PM_30_20_89	11.01.2024	Topographic survey

3.2 Specific details of the buildingSMART Portugal EIR

4. Support information

- 4.1 Reference information
- **4.2 Shared resources**

4.2. Shared resources

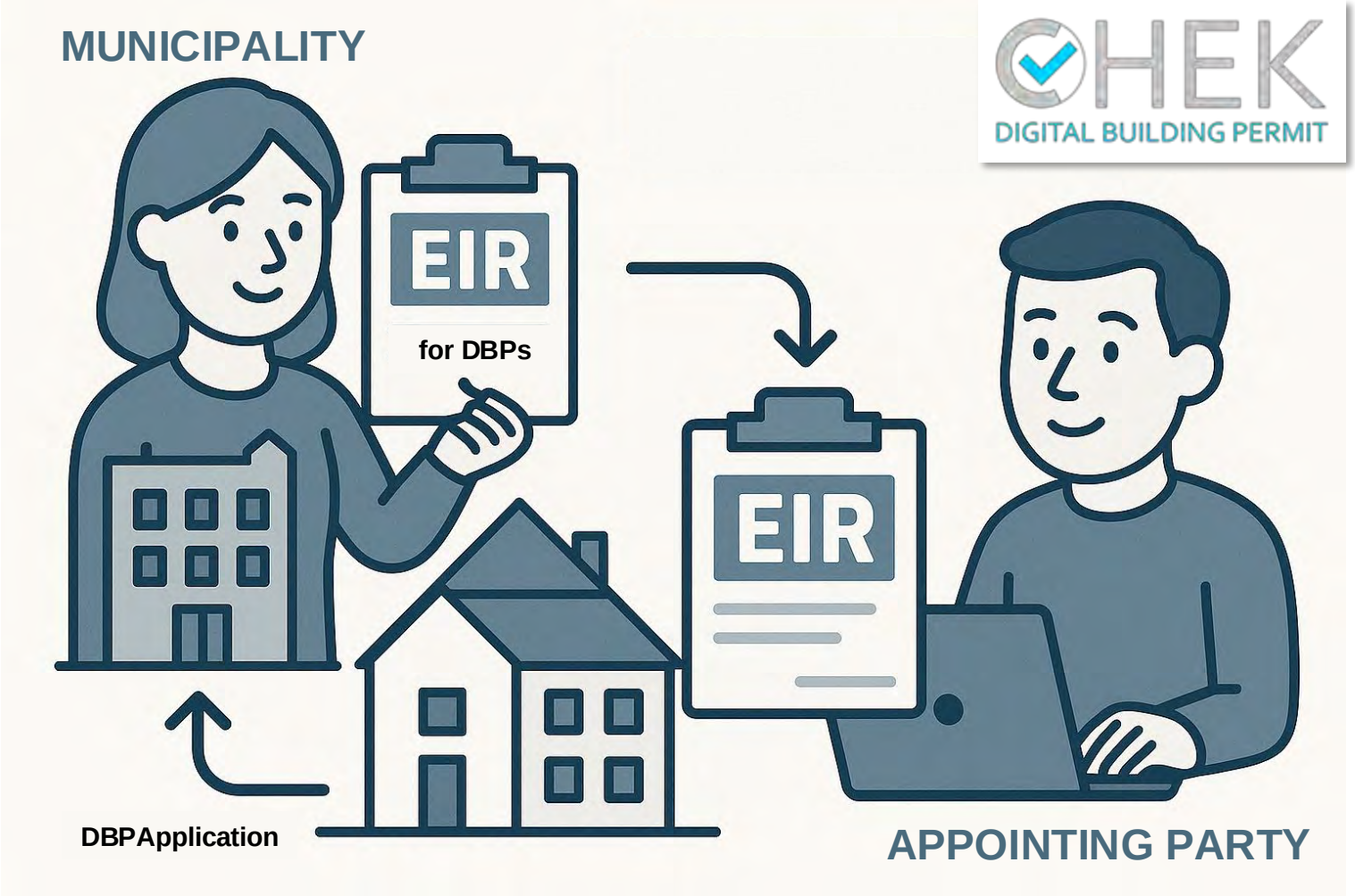
Nomenclature	State	Revision	Classification	Date	Description
OBG-BSP-ZZ-ZZZ-RL-XXX-XX-0001.docx	A1	C01	FI_90_88	11.01.2024	Reports template
OBG-BSP-ZZ-ZZZ-RL-XXX-XX-0002.dwg	A1	C01	FI_90_88	11.01.2024	Cover sheet template
OBG-BSP-ZZ-ZZZ-EP-XXX-XX-0001.ids	A1	C01	PM_40_30	28.11.2024	IDS General
OBG-BSP-ZZ-ZZZ-EP-ARQ-XX-0001.ids	A1	C01	PM_40_30	28.11.2024	IDS Architecture
OBG-BSP-ZZ-ZZZ-EP-EST-XX-0001.ids	A1	C01	PM_40_30	28.11.2024	IDS Structures
OBG-BSP-ZZ-ZZZ-EP-XXX-XX-0002.ids	A1	C01	PM_40_30	28.11.2024	IDS MEP

3.2 Specific details of the buildingSMART Portugal EIR

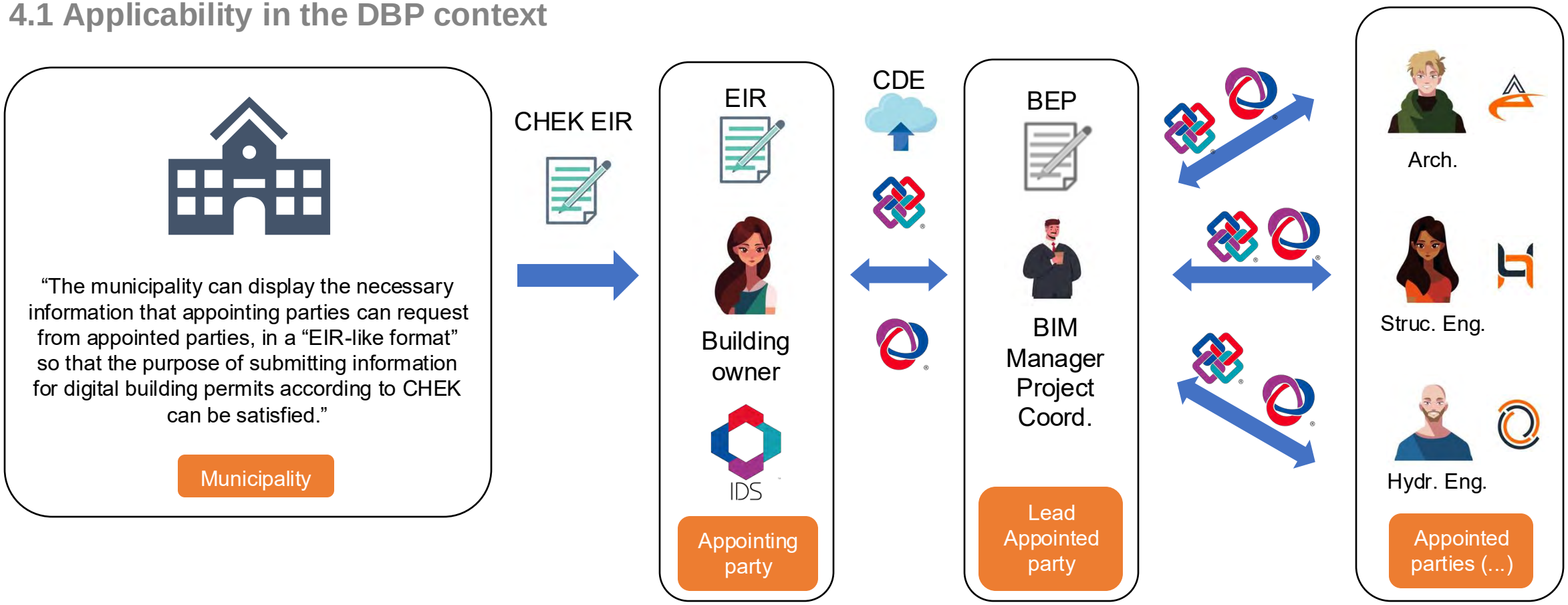
5. Dates, information delivery milestones and key decision points

EIR	Delivery date of the deliverable	Key decision point	Delivery date of the result of the key decision point
Preliminary Design			
EIR01 EIR02 EIR03 EIR04 EIR09 EIR10	02/04/2024 (10 days before the decision is made)	Decision point 2: • Decision on the level of BREEAM certification that is really desired, taking into account performance objectives and budgetary limits. • Decision on continuity of investment and possible adaptations to strategic objectives.	12/04/2024 (7 weeks before the end of the phase)
EIR04 EIR08 EIR09 EIR10	21/08/2024 (10 days before the decision is made)	Decision point 3: • Decision on final approval of phase with possible amendments.	31/08/2024 (end of the phase)
EIR05	Coordination of the models takes place before the coordination meetings, and the results of the coordination must be communicated at least 2 working days before the coordination meetings.		
EIR06	Coordination meetings held fortnightly (start date to be determined).		
Developed Design			
EIR04 EIR07 EIR08 EIR09 EIR10	22/03/2024 (10 days before the decision is made)	Decision point 3: • Decision on final approval of phase with possible amendments.	01/04/2024 (end of the phase)
EIR05	Coordination of the models takes place before the coordination meetings, and the results of the coordination must be communicated at least 2 working days before the coordination meetings.		
EIR06	Coordination meetings held fortnightly (start date to be determined).		
Technical Design			
EIR04 EIR07 EIR10 EIR11 EIR12 EIR13	10 days before the decision is made	Decision point 3: • Decision on final approval of phase with possible amendments.	In the end of the phase.
EIR05	Coordination of the models takes place before the coordination meetings, and the results of the coordination must be communicated at least 2 working days before the coordination meetings.		
EIR06	Coordination meetings held fortnightly (start date to be determined).		

Let’s now explain how the EIR can be applied in the DBP context…

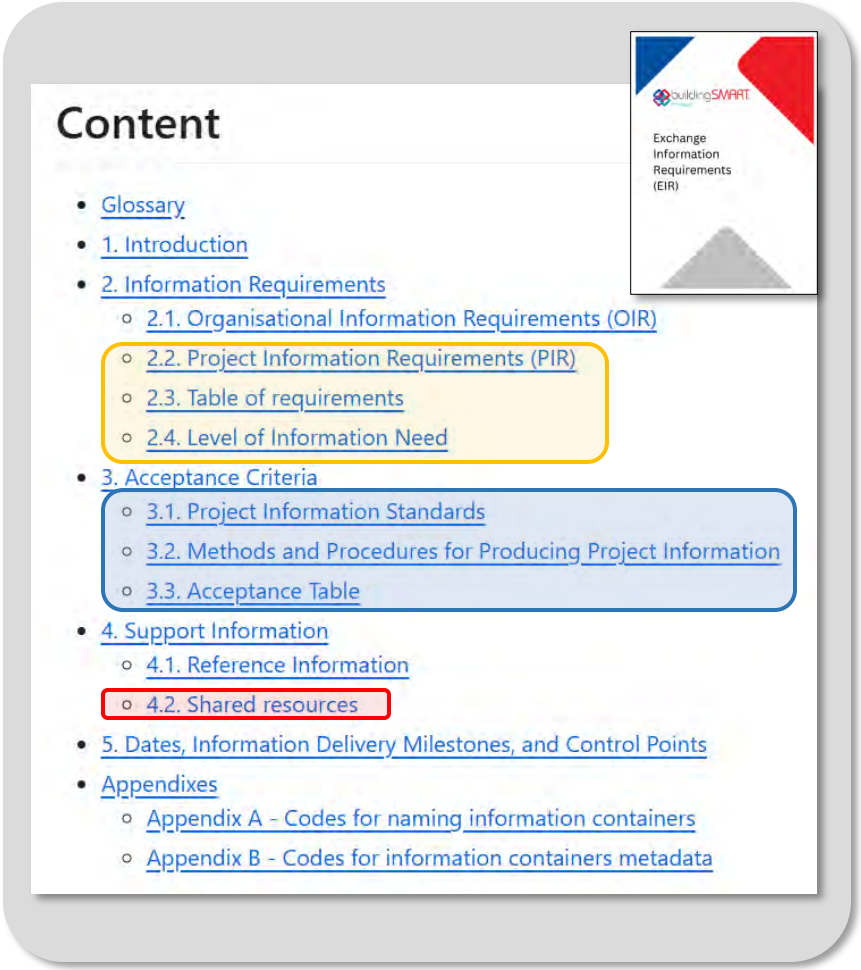


4.1 Applicability in the DBP context

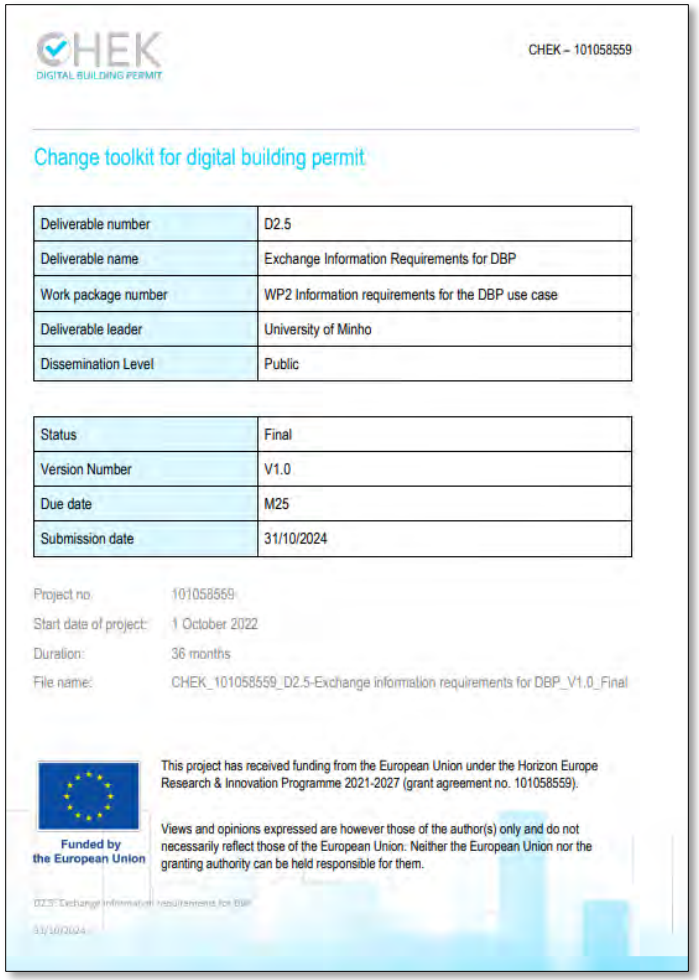


4.2 CHEK EIR Example

buildingSMART Portugal EIR table of contents



CHEK EIR



The CHEK EIR has been developed in the following context:

- Based on the Ascoli Piceno case.
- Considering the CHEK Project phase at that time (october/2024).
- This is a “work in progress” that can be updated as the project develops.

3.2 Specific details of the CHEK EIR

2. Information requirements

2.1 Organizational Information Requirements (OIR)

✓ **2.2 Project Information Requirements (PIR)**

2.2.1 Appointing Party

2.2.2 Commercial name of the project

2.2.3 Project scope

✓ **2.2.4 Purposes for which the information will be used by the Appointing Party**

2.2.5 Phases

2.2.6 Hiring process

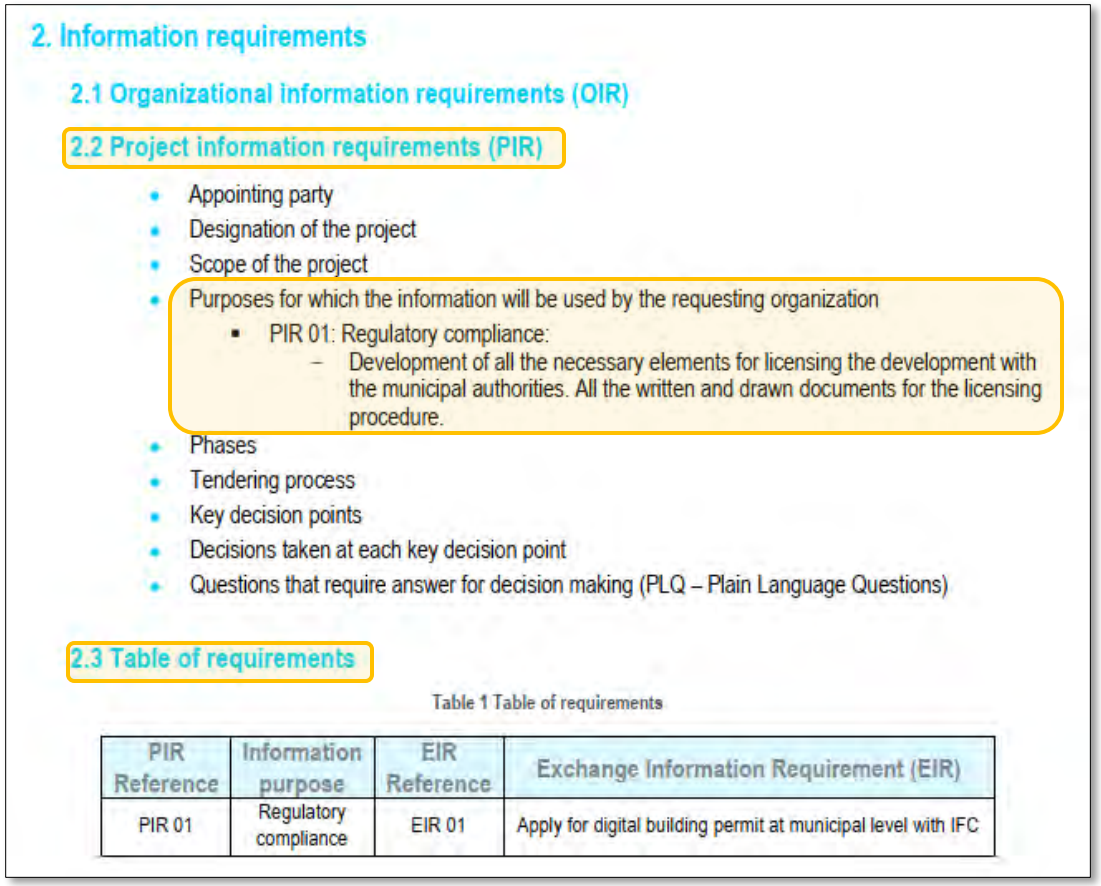
2.2.7 Key decision points

2.2.8 Decisions that will be taken at each key decision point.

2.2.9 Questions that need to be answered for informed decision-making. (PLQ)

✓ **2.3 Table of requirements**

2.4 Level of Information Need



2. Information requirements

2.1 Organizational information requirements (OIR)

2.2 Project information requirements (PIR)

- Appointing party
- Designation of the project
- Scope of the project
- Purposes for which the information will be used by the requesting organization
  - PIR 01: Regulatory compliance:
    - Development of all the necessary elements for licensing the development with the municipal authorities. All the written and drawn documents for the licensing procedure.
- Phases
- Tendering process
- Key decision points
- Decisions taken at each key decision point
- Questions that require answer for decision making (PLQ – Plain Language Questions)

2.3 Table of requirements

Table 1 Table of requirements

PIR Reference	Information purpose	EIR Reference	Exchange Information Requirement (EIR)
PIR 01	Regulatory compliance	EIR 01	Apply for digital building permit at municipal level with IFC

3.2 Specific details of the CHEK EIR

2. Information requirements

- 2.1 Organizational Information Requirements (OIR)
- ✓ **2.2 Project Information Requirements (PIR)**
  - 2.2.1 Appointing Party
  - 2.2.2 Commercial name of the project
  - 2.2.3 Project scope
  - ✓ **2.2.4 Purposes for which the information will be used by the Appointing Party**
  - 2.2.5 Phases
  - 2.2.6 Hiring process
  - 2.2.7 Key decision points
  - 2.2.8 Decisions that will be taken at each key decision point.
  - 2.2.9 Questions that need to be answered for informed decision-making. (PLQ)
- ✓ **2.3 Table of requirements**
- ✓ **2.4 Level of Information Need**

2.4 Level of Information Need

The development of the tables with the Level of Information Need (EN ISO 7817-1:2024) to be followed in the various exchanges of information between the different actors is the responsibility of the Lead Appointed Party. The tables must be contained in the BEP, and in this document, there are reference tables with minimum requirements. The appointed parties must include alphanumeric information which has not been provided for in the aforementioned tables and which is relevant to characterizing the objects of the project.

1. Introduction

The Level of Information Need for Ascoli Piceno is a living document that is still being developed in the project. Currently, the Level of Information Need contains 15 tables (see Table 1) which were included in this annex at the time of the submission of this deliverable. The tables can also be found at the following link: Architecture.

Table 1 - List of tables of the Level of Information Need - Ascoli Piceno

Tables	Objects
1	Building
2	Roof
3	Chimney
4	Other elements on the roof
5	Space type
6	Spaces
7	Building Storey
8	Wall
9	Column
10	Door
11	Window
12	Stairwell
13	Elevator
14	Project
15	Terrain

3.2 Specific details of the CHEK EIR

2. Information requirements

- 2.1 Organizational Information Requirements (OIR)
- ✓ **2.2 Project Information Requirements (PIR)**
  - 2.2.1 Appointing Party
  - 2.2.2 Commercial name of the project
  - 2.2.3 Project scope
  - ✓ **2.2.4 Purposes for which the information will be used by the Appointing Party**
  - 2.2.5 Phases
  - 2.2.6 Hiring process
  - 2.2.7 Key decision points
  - 2.2.8 Decisions that will be taken at each key decision point.
  - 2.2.9 Questions that need to be answered for informed decision-making. (PLQ)
- ✓ **2.3 Table of requirements**
- ✓ **2.4 Level of Information Need**

2.1 Building

Objects		*Building*	
Actor		*Applicant for permit*	
			Information Delivery Milestone
			Building permit
Purpose			*Apply for digital building permit at municipal level*
Minimum geometric information requirements			
	Details		*Not applicable*
	Dimension		*Not requested*
	Location		*Relative*
	Appearance		*Not applicable*
	Parametric behavior		*Not applicable*
Minimum alphanumeric information requirements			
	IFC Class		*IfcBuilding*
	Attributes		
	Name		X
	Property sets		
	Properties	**Property set**	
	TypeOfConstruction	*CHEK_common*	X
	Height	*CHEK_common*	X
	IsCornerBuilding	*CHEK_common*	X
	NumberOfBuildingLevels	*CHEK_common*	X
	MarketCategory	*Pset_BuildingUse*	X
	MarketSubCategory	*Pset_BuildingUse*	X
	BuildingHeight	*CHEK_common*	X

4. EIR in the DBP context

3.2 Specific details of the CHEK EIR

3. Acceptance criteria

- ✓ **3.1 Project information standards**
  - ✓ **3.1.1 Standards**
  - ✓ **3.1.2. Nomenclature of information containers – Files**
  - 3.1.3 Metadata of information containers – Files
  - 3.1.4 Nomenclature of information blocks - IFC: Objects and alphanumeric information
  - ✓ **3.1.5 Units system**
  - ✓ **3.1.6 Coordinate system**
  - 3.1.7 Information classification
  - ✓ **3.1.8 Format and size of information containers**
  - 3.1.9 Software - Appointed Parties
  - ✓ **3.1.10 Platforms and software of the Appointing Party**
  - 3.1.11 Information for the asset management operational phase
  - **3.2 Methods and procedures for producing project information**
  - 3.2.1 Capturing information from existing assets
  - **3.2.2 Creation, revision and approval of new information**
  - 3.2.3 Delivery of information to the Appointing Party
  - 3.2.4 Security
- 3.3 Acceptance table
  - 3.3.1 Overall assessment
  - 3.3.2 Model Quality

3.1 Project information standards

Project information standards aim to describe the criteria that will provide support and consistency for the information that will be developed throughout the project. According to clause 5.1.4 of EN ISO 19650-2, their definition must consider how information will be exchanged, the structure and classification of the information, the method used to specify the Level of Information Need and the use of the information in post-project phases and for asset operation.

- Standards
  EN ISO 19650 series and EN ISO 7817-1:2024 and other relevant standards at national level.
- Naming of information blocks – Files
  The nomenclature must follow any national requirements. In the absence of national or other specific indications, the following is suggested: [insert UK national annex]
- Metadata for information containers
- Nomenclature for IFC objects
- Units
  International System of Units consistent with Directive 80/181/EEC and its addenda. ISO 80000-1:2022. The monetary unit is €.
- Coordinate system
  The coordinate system to adopt for Ascoli Piceno EPSG:3004.
- Classification system
- Format and size of information containers
  - Editable documents and spreadsheets following the ISO/IEC 29500-1:2016 standard (XLSX and DOCX formats are valid, for example).

- Platform and software – Appointing Party
  The appointing party must perform submission through the CHEK platform.
- Information for the operational phase of the asset

4. EIR in the DBP context

3.2 Specific details of the CHEK EIR

3. Acceptance criteria

- ✓ 3.1 Project information standards
  - ✓ 3.1.1 Standards
  - ✓ 3.1.2. Nomenclature of information containers – Files
  - 3.1.3 Metadata of information containers – Files
  - 3.1.4 Nomenclature of information blocks - IFC: Objects and alphanumeric information
  - ✓ 3.1.5 Units system
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  - ✓ **3.2.2 Creation, revision and approval of new information**
  - 3.2.3 Delivery of information to the Appointing Party
  - 3.2.4 Security
- 3.3 Acceptance table
  - 3.3.1 Overall assessment
  - 3.3.2 Model Quality

3.2 Methods and procedures for project information production

The project's information production methods and procedures define the approaches and techniques that the requesting entity uses to create, manage and approve information.

- Capture of information on existing assets
- 3.2.2 Production, review and approval of new information

a) Information production:

All IFC files shall be created with the Reference View MVD from IFC 4 ADD2 TC1.
The submission for permitting shall include two distinct model containers (files):

- One for the underlying terrain of the plot (and all entities outside the main construction(s)/building(s)) for which the permit is required). This is henceforward referred to as TERR.
- One for the construction (e.g. building) itself (or one file per each building being analyzed), as an architectural domain model. This is henceforward referred to as CONSTR.

TERR model shall contain an IFCSite, and does not need to meet specific requirements other than those set for the Site (and respective georeferencing) in the Level of Information Need Specification. All geometry not directly connected to the building or within the building should be defined in TERR. This second IFC file will not contain an IFCBUILDING instance and is not CHEK IFC compliant.

CONSTR model(s) shall respect all the requirements set in this EIR and must contain only one IFCBUILDING.

The terrain should be modeled to match the limits of the parcel or plot.

The production of native models and associated data must allow the creation of IFC models. Proxy objects must not be used when a specific object class is available in the IFC standard.

The design team must define an origin for the coordinate reference point of the design. This origin should be common to all models.

The local reference point may have a rotation relative to true north, and this rotation must be identified and justified in the BIM Execution Plan.

3.2 Specific details of the CHEK EIR

3. Acceptance criteria

- ✓ **3.1 Project information standards**
  - ✓ **3.1.1 Standards**
  - ✓ **3.1.2. Nomenclature of information containers – Files**
  - 3.1.3 Metadata of information containers – Files
  - 3.1.4 Nomenclature of information blocks - IFC: Objects and alphanumeric information
  - ✓ **3.1.5 Units system**
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  - ✓ **3.1.8 Format and size of information containers**
  - 3.1.9 Software - Appointed Parties
  - ✓ **3.1.10 Platforms and software of the Appointing Party**
  - 3.1.11 Information for the asset management operational phase
- ✓ **3.2 Methods and procedures for producing project information**
  - 3.2.1 Capturing information from existing assets
  - ✓ **3.2.2 Creation, revision and approval of new information**
  - 3.2.3 Delivery of information to the Appointing Party
  - 3.2.4 Security
- ✓ **3.3 Acceptance table**
  - 3.3.1 Overall assessment
  - ✓ **3.3.2 Model Quality**

3.3 Acceptance tables

- Global evaluation
- Model quality

Perform model checks to identify and rectify issues such as duplicate elements, missing properties, or geometric inaccuracies.

For checking the adequacy of georeferencing of the model, the CHEK IFC Georeferencing tool can be used: https://ifcgref.bk.tudelft.nl/.

Self-checking of satisfaction of information requirements through the IDS supplied by the Municipality is necessary.

1. Geometry:
2. Non-graphical information:


CHEK
DIGITAL BUILDING PERMIT

DIGITAL BUILDING PERMIT

Module 3 - Interoperability, openBIM and IFC

8th July 2025

José Granja, Miguel Azenha, Bruno Muniz, José Carlos Lino

Funded by
the European Union

Interoperability and openBIM

Concept of Interoperability

Cambridge Business Dictionary - Interoperability
"*the degree to which two products, programs, etc. can be used together, or the quality of being able to be used together.*"

In the BIM context, interoperability is defined as the ability to transmit data between applications, as well as the ability of several applications to work together.

The aim is to eliminate the need to 'manually copy' information between different applications, **speeding up processes** and **minimising errors**.



Interoperability in a CAD context

IGES - Initial Graphics Exchange Specification

- Joint initiative by Nasa, Boeing and General Electric to create a universal file format for CAD (public domain);
- Published in 1980 by the US National Bureau of Standards (NIST);
- A great success in various industries, it is still a format supported by most software today (for consulting old models) -> last version is from 1996.

DXF – Drawing eXchange Format

- Unilateral initiative by Autodesk;
- Created at the end of 1982;
- Some success in simple drawings;
- Limitations in the representation of solids and regions.

Application Programming Interfaces (APIs)

Worldwide interoperability standardisation efforts

- In the context of industry in general, the first version of the ISO-10303 standard was published in 1994 to standardise interoperability;
- ISO-10303 - Industrial automation systems and integration - Product data representation and exchange. Alternative name: ISO-STEP ‘Standard for the Exchange of Product Model Data’;
- As part of ISO-STEP, the EXPRESS language (ISO 10303-11:2004) was developed to support product modelling in various industries: electrical systems, mechanical systems, shipbuilding, furniture, buildings, etc;
- The EXPRESS language contains an extensive library for characteristics, geometry, classification, measurement, etc...

General about the EXPRESS language

- The model can be expressed in text format (EXPRESS) or graphical format for easier reading (EXPRESS-G);
- The language is defined by a data structure (schema) with mutual links and specific rules;

```
SCHEMA Family;

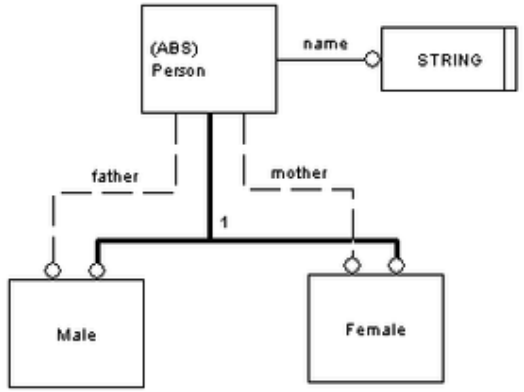
ENTITY Person
   ABSTRACT SUPERTYPE OF (ONEOF (Male, Female));
     name: STRING;
     mother: OPTIONAL Female;
     father: OPTIONAL Male;
END_ENTITY;

ENTITY Female
   SUBTYPE OF (Person);
END_ENTITY;

ENTITY Male
   SUBTYPE of (Person);
END_ENTITY;

END_SCHEMA;
```

SCHEMA Family in EXPRESS

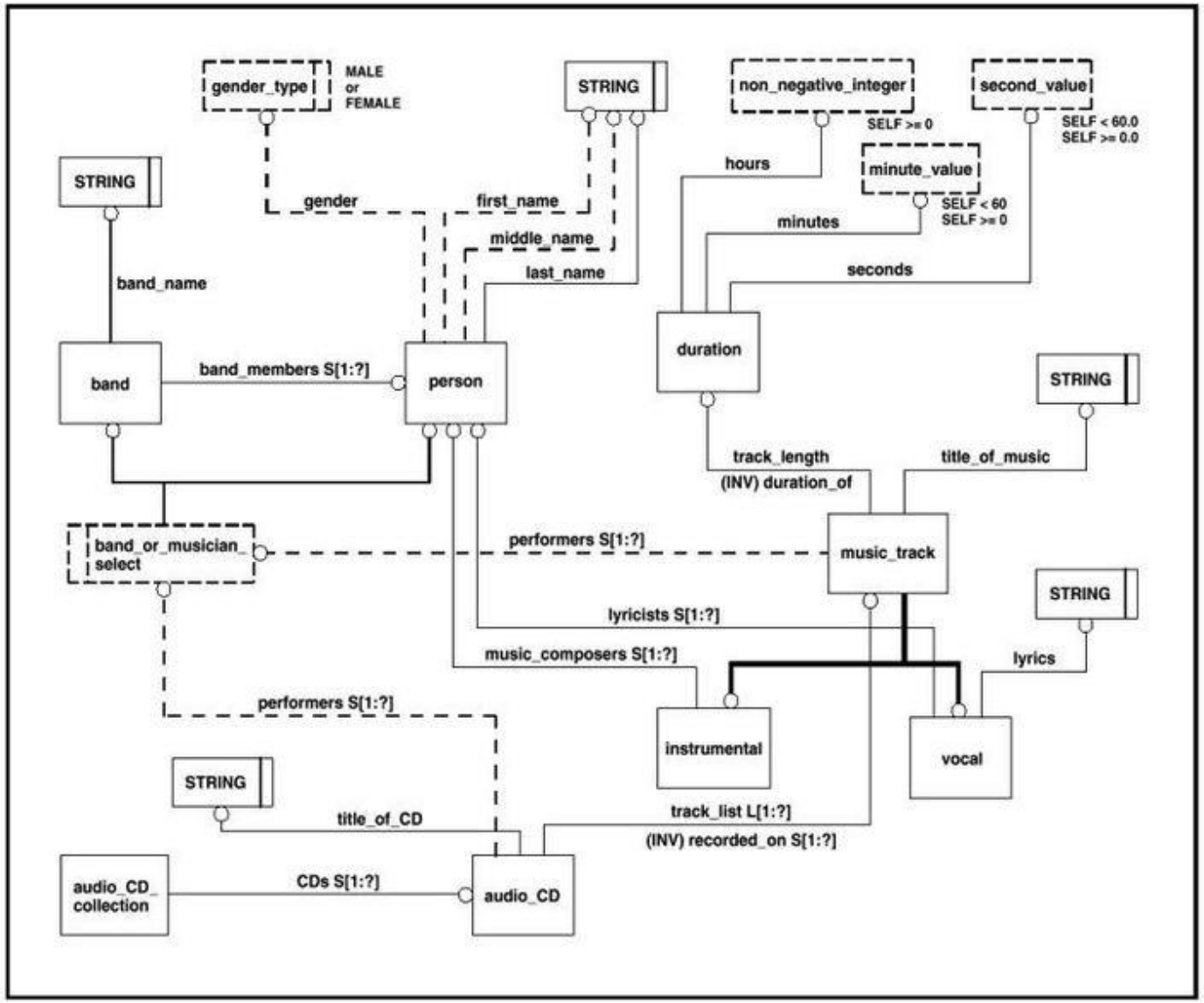


SCHEMA Family in EXPRESS-G

```
TYPE day_in_week_number = INTEGER; WHERE
WR1: (1 <= SELF) AND (SELF <= 7);
END_TYPE; -- day_in_week_number
```

Rule in EXPRESS

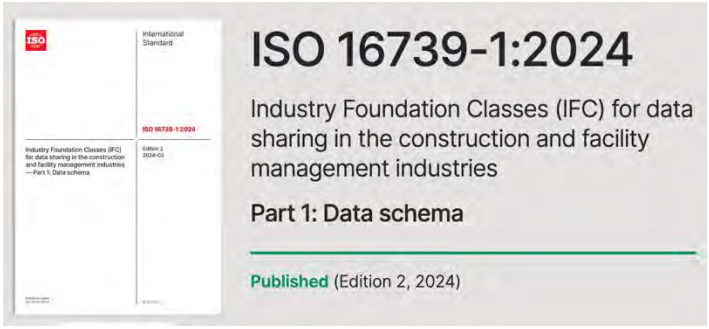
Data from a Compact Disc (CD) in EXPRESS-G



buildingSMART and IFC

- Efforts started in 1994 by Autodesk, which invited a consortium of companies to develop C++ classes that could support integrated application development;
- buildingSMART is a non-profit organisation (http://www.buildingsmart.org/) with National Chapters for local support (https://buildingsmart.pt/).





- **Standardised Data Model:** IFC is a standardised data schema developed by buildingSMART that describes building objects, their properties and relationships in a consistent way.
- **Object-Oriented Structure:** Utilises an object-oriented approach, where elements such as walls, doors and systems are represented as entities with specific attributes.
- **Geometric representation of information:** Supports both the precise 3D geometry of components and non-geometric information such as materials, costs and schedules.
- **Interoperability through XML and EXPRESS Schemas (ISO-STEP):** IFC is defined using data modelling languages such as EXPRESS and can be serialised in formats such as STEP and XML, facilitating the exchange of data between systems.
- **Multidisciplinary Coverage:** Covers various construction disciplines, including architecture, structural engineering, building installations and facilities management, allowing for an integrated view of the project.

Scope of the IFC according to ISO 16739:2013 (1/2)

Definition of exchange formats that are needed during the phases of the building life cycle:

- Demonstration of need
- Conception of need
- Feasibility framework
- Feasibility study and financial issues
- Conceptual design outline
- Complete conceptual design
- Coordinated design
- Contracting
- Information for production
- Construction
- Operation and maintenance

Scope of the IFC according to ISO 16739:2013 (2/2)

Definition of the exchange formats required by the various disciplines involved in the various stages of the life cycle:

- Architecture
- Structural Engineering
- Engineering specialities in general
- Contracting
- Construction planning
- Building management
- Project management
- Management of client requirements
- Approval by the competent authorities

IFC Specifications Database

https://technical.buildingsmart.org/standards/ifc/ifc-schema-specifications/

Official releases of the IFC specification are listed here, as well as their components including HTML, EXPRESS, XSD/XML, and OWL documentation and formats.

Release Notes and Errata for all versions can be found here.

Version	Name (HTML Documentation)	ISO publication	Published (yyyy-mm)	Current Status	Full package	EXPRESS	XSD	pSet XSD	OWL HTML	RDF	TTL
5.0 dev	IFC 5 dev			Next generation IFC. Refactoring of the IFC 4.x content. Currently under development.	GitHub	n.a.		n.a.			
4.4 - dev	IFC 4.4.x dev			Potential extension of 4.3. Adding additional functionality. Currently in planning phase.							
4.3.2.0	IFC 4.3 ADD2	ISO 16739-1:2024	2024-04	Official	ZIP	EXP	XSD	ZIP	ifcOWL		TTL (use correct MIME type)
4.2.0.0	IFC 4.2	-	2019-04	Withdrawn	ZIP	EXP	IFC4x2.xsd	-			
4.1.0.0	IFC 4.1	-	2018-06	Withdrawn	ZIP	EXP	IFC4x1.xsd	-			
4.0.2.1	IFC 4 ADD2 TC1	ISO 16739-1:2018	2017-10	Official	ZIP	EXP	IFC4.xsd	-	IfcOWL	RDF	TTL
4.0.2.0	IFC 4 ADD2	-	2016-07	Retired	ZIP	EXP	IFC4_ADD2.xsd	-			
4.0.1.0	IFC 4 ADD1	-	2015-06	Retired	ZIP	EXP	IFC4_ADD1.xsd	-			
4.0.0.0	IFC 4	ISO 16739:2013	2013-02	Retired	ZIP	EXP	ifcXML4.xsd	PSD_IFC4.xsd	ifcOWL	RDF	TTL
2.3.0.1	IFC 2x3 TC1	ISO/PAS 16739:2005	2007-07	Official	ZIP	EXP	IFC2X3.xsd	PSD_R2x3.xsl	ifcOWL	RDF	TTL

IFC4.3 RC1 (4.3.rc.1)

The main purpose of IFC4.3 is to extend the IFC schema to cover the description of infrastructure constructions within the domains of Railways, Roads, Ports and Waterways including the elements that are common across those domains. The IFC4.3 schema has been developed to:

- enhance the current definition of alignment and linear positioning to include railway cant within its geometric representation and span placements to provide “from-to” positioning;
- enhance the current geometry definitions for advanced sweeps to add a sweep operation taking cant into account, and for advanced surfaces to represent road surfaces;
- rationalize and enhance the definition of spatial structure to uniformly define a breakdown structure for all domains in question; and
- rationalize and enhance the current specialization structure of products and product types to reflect the taxonomy of the new domains Railways, Roads, Ports and Waterways and common domains such as geotechnics and earthworks.

The extensions made to the IFC4.2 schema include in detail:

- 62 new occurrence entities (including corresponding type entities where indicated) have been created:
  - 24 proposed by the Shared Infrastructure domain, to support:
    - the signalling occurrence and type entities (*IfcSign__[Type]*, *IfcSignal__[Type]*);
    - the earthworks concepts (*IfcEarthworksCut*, *IfcEarthworksElement*, *IfcEarthworksFill*, *IfcReinforcedSoil*);
    - the above-ground works occurrence and type entities (*IfcPavement__[Type]*, *IfcCourse__[Type]*, *IfcImpactProtectionDevice__[Type]*, *IfcPlant*);
    - the geotechnical concepts (*IfcGeotechnicalAssembly*, *IfcGeotechnicalElement*, *IfcGeotechnicalStratum*, *IfcGeomodel*, *IfcGeoslice*, *IfcBorehole*, *IfcSolidStratum*, *IfcVoidStratum*, *IfcWaterStratum*).
  - 22 from the Railways domain to support:
    - the spatial structure (*IfcRailway*);
    - the geometric representation of alignment considering the railway cant (*IfcAlignment2DCant*, *IfcAlignment2DCantSegLine*, *IfcAlignment2DCantSegment*, *IfcAlignment2DCantSegTransition*, *IfcAlignment2DVerSegTransition*, *IfcAxisLateralInclination*, *IfcLinearAxisWithInclination*);
    - the linear placement considering railway cant (*IfcLinearPlacementWithInclination*);
    - the creation of swept area solid (*IfcDirectrixCurveSweptAreaSolid*, *IfcDirectrixDistanceSweptAreaSolid*, *IfcInclinedReferenceSweptAreaSolid*);
    - the built element (track concepts) occurrence and type entities (*IfcRail[Type]*, *IfcTrackElement[Type]*);
    - the distribution element occurrence and type entities (*IfcDistributionBoard[Type]*, *IfcElectricFlowTreatmentDevice[Type]*, *IfcMobileTelecommunicationsAppliance[Type]*).
  - 7 from the Roads domain to support:

IFC 4.3 schema

https://standards.buildingsmart.org/IFC/RELEASE/IFC4_3/

IFC 4.3.2.0 (IFC4X3_ADD2) official | Help improve the next version | Get user or developer support

Cover
Contents
Foreword
Introduction
1 Scope
2 Normative references
3 Terms, definitions, and abbreviated terms
4 Fundamental concepts and assumptions
5 Core data schemas
6 Shared

Content

This is the official **4.3.2.0** documentation for "IFC 4.3".
It is the version as it has been send to ISO and has the exact same content as the ISO publication.
Since the official publication there have been additional examples and clarifications added to the documentation. These can be found on this link. This link also includes information on the MVDs, that is not included in this static publication. The additional clarifications do not alter the structure and schema of this official static publication.



Edit on Github

4 contributor(s):

Last change: *Update cover.md clarifications typo fix* by Léon van Berlo on 09/05/2024, 20:08:59

Is this page difficult to understand? Let us know!

The GUID concept

8.21.2.2 IfcGloballyUniqueId

8.21.2.2.1 Semantic definition

An *IfcGloballyUniqueId* holds an encoded string identifier that is used to uniquely identify an IFC object. An *IfcGloballyUniqueId* is a Globally Unique Identifier (GUID) which is an auto-generated 128-bit number. Since this identifier is required for all IFC object instances, it is desirable to compress it to reduce overhead. The encoding of the base 64 character set is shown below:

```
          1         2         3         4         5         6
 01234567890123456789012345678901234567890123456789012345678901234567890123
"0123456789ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz_$";
```

The resulting string is a fixed 22 character length string to be exchanged within the IFC exchange file structure.

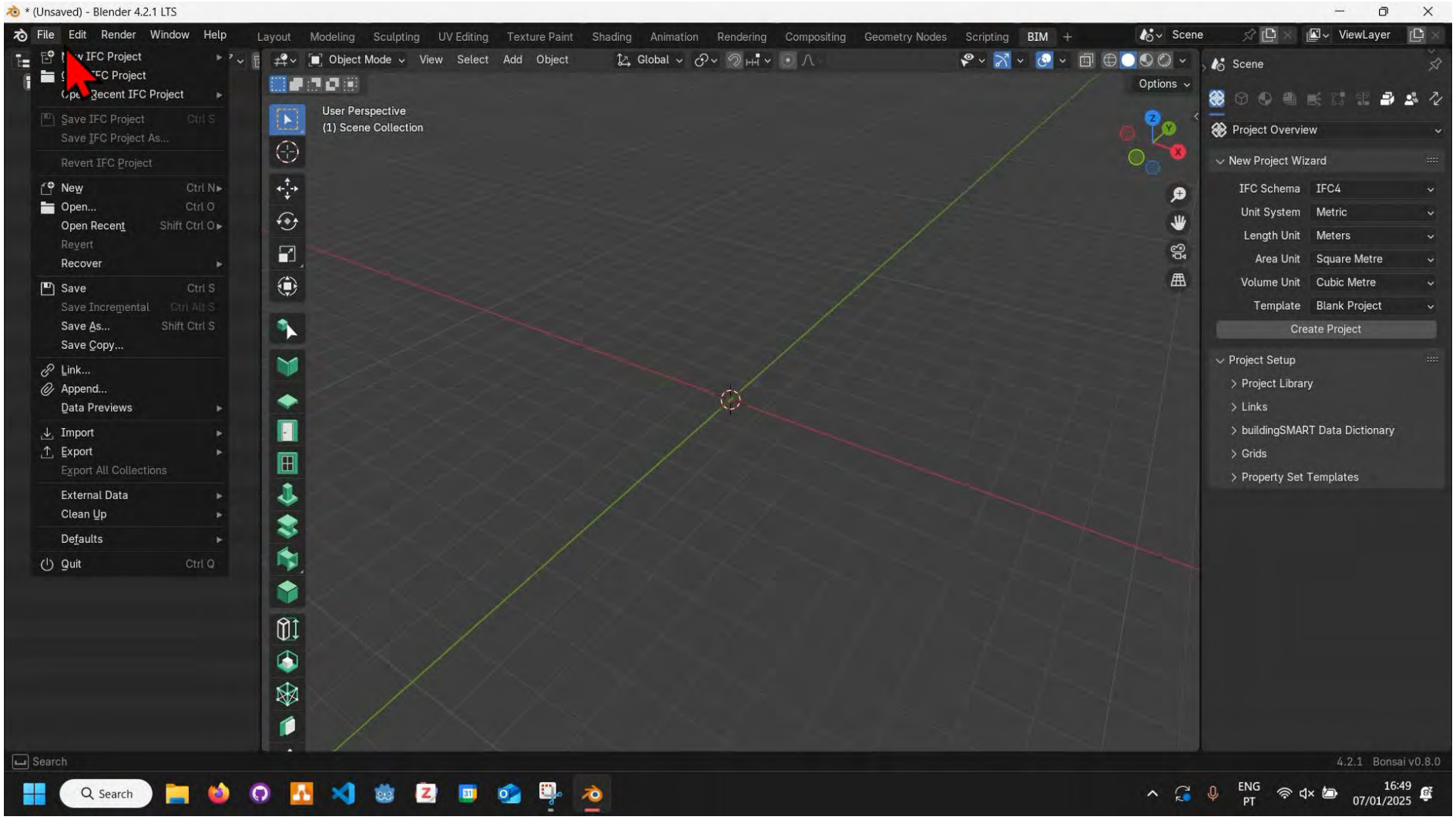
The base64 encoding process may differ from common base64 implementations. The following steps are used:

1. The first byte is encoded in the first two characters
2. The remaining bytes are encoded in groups of 3, taking up 4 characters

As a result, the first character must be either a 0, 1, 2, or 3.

EXAMPLE the generated base16 number f70dd363-bfe3-495d-84a0-2c02dcb7d4d2 will compress to 3t3TDZI_D9NOIWB0BSjzJI

Let's open an IFC and confirm that the objects all have GUIDs



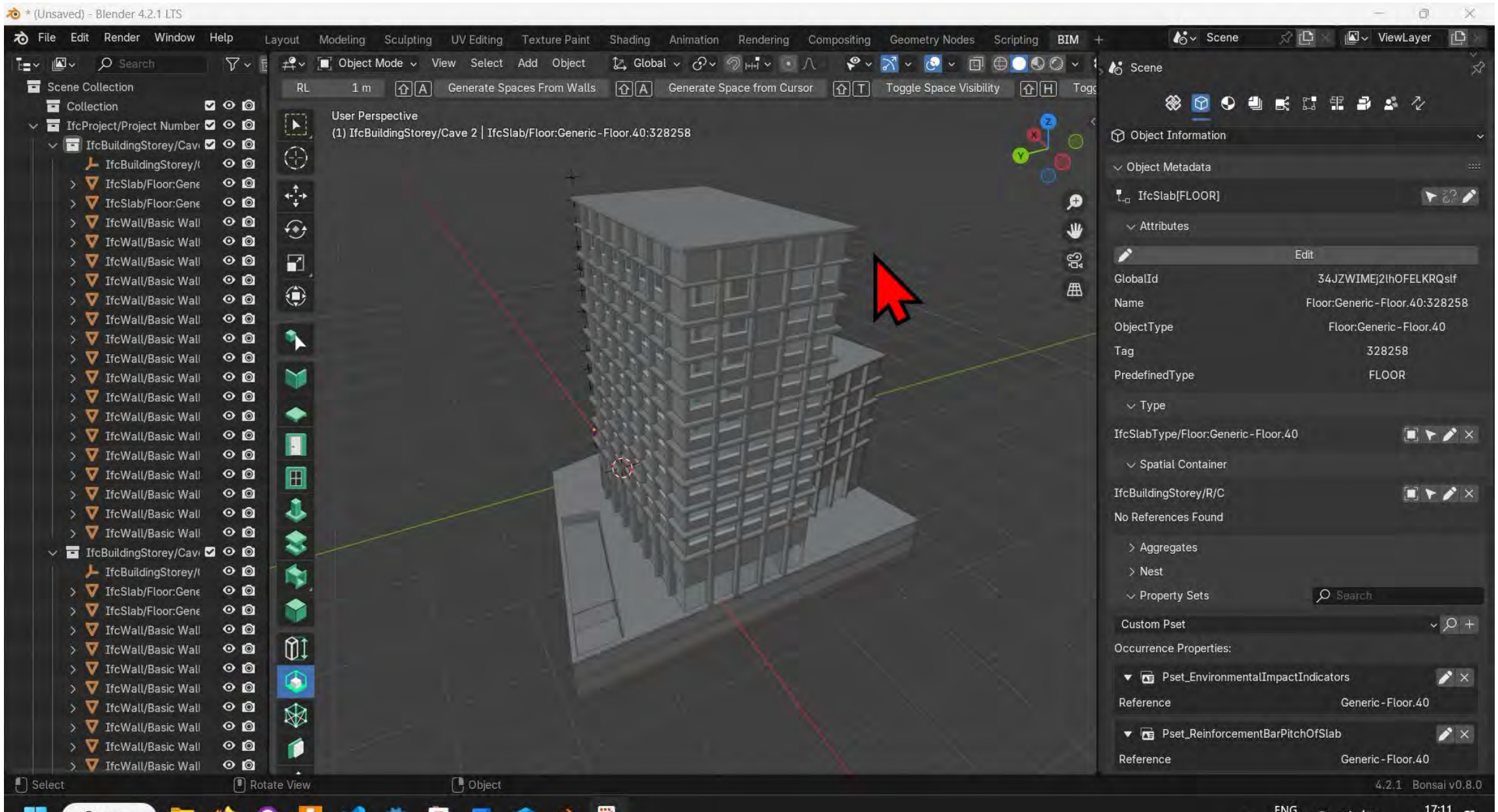
Remember the “Level of Information Need”?

Object		*Beams*	
Appointing Party		*Building Owner*	
Apointed Party		*Structural engineer*	
			PROJECT PHASE / DELIVERY MILESTONE:
			Technical Design
Minimum geometric information requirements			
Detail			*The dimensions of the element are correctly defined. Connections, links and the representation of any regions that may have an impact on coordination with other systems.*
Dimensionality			*3D*
Location			*Relative*
Appearance			*Appearance equivalent to real visualisation, with texture equivalent to the material in view.*
Parametric behaviour			*Not requested*
Minimum alphanumeric information requirements			
IFC class			*IfcBeam*
Attributes			
Name			*X*
redefi pe			*X*
Property sets			
	Property	**Property set**	
	StrengthClass	*Pset_ConcreteElementGeneral*	*X*
	ExposureClass	*Pset_ConcreteElementGeneral*	*X*
	ConcreteCover	*Pset_ConcreteElementGeneral*	*X*
	ReinforcementStrengthClass	*Pset_ConcreteElementGeneral*	*X*
	NetVolume	*Qto_BeamBaseQuantities*	*X*
als			
Name			*X*
Classification			
	System	**Table**	
	SECClasS	*Systems*	*X*

Let's look for these in particular. They could be defined by the IFC, or by a data dictionary platform (identifiable by the ‘set of properties’ column).

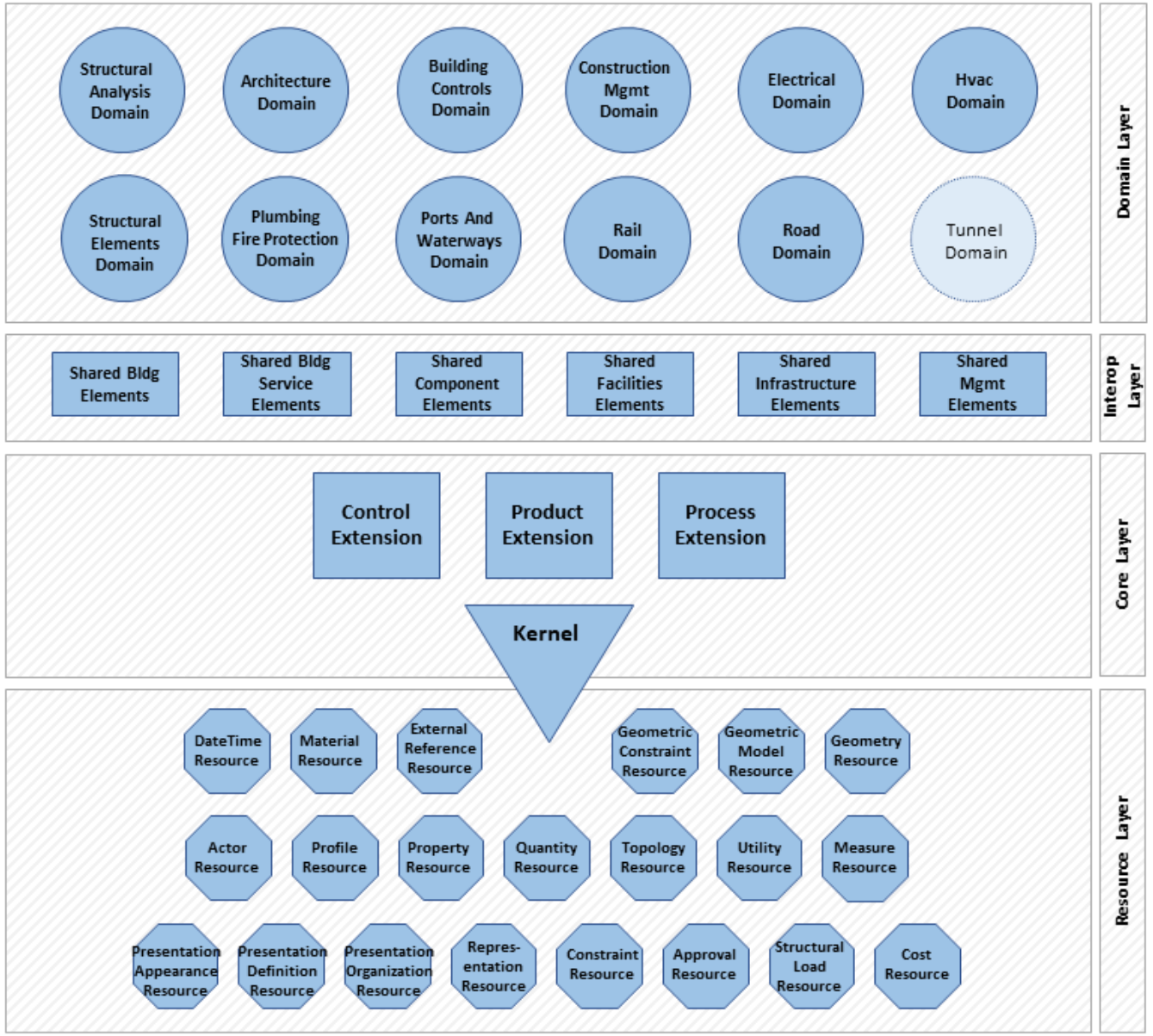
A guided tour of an IFC

www.chekdbp.eu




THE FELOWING
CONTENT
IS APPROVED FOR
BIM JEDIS ONLY
THE FELLOWING CONTTIS APPROVED
BIM JEDIS ONLY.

IFC Architecture – 4.3



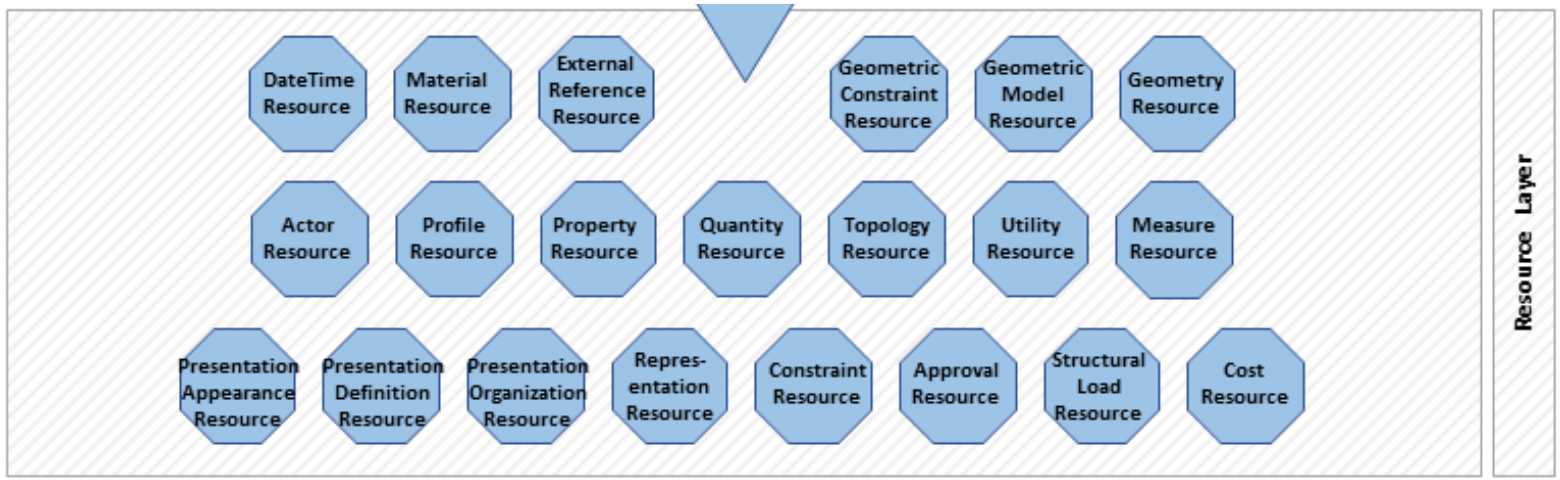
Industry Foundation Classes version 4.3.x Architecture overview

IFC Architecture – 4.3 – Resource layer

The lowest layer includes all individual schemas containing resource definitions.
Entities and types defined in this layer can be referenced by all entities in the other layers

- cannot exist independently, but can only exist if referenced (directly or indirectly) by one or more entities deriving from IfcRoot (unlike other layers)
- Contains the categories of entities that represent basic properties such as geometry, materials, quantities, dates, times, costs, etc…;
- Properties are generic and do not necessarily apply to buildings.

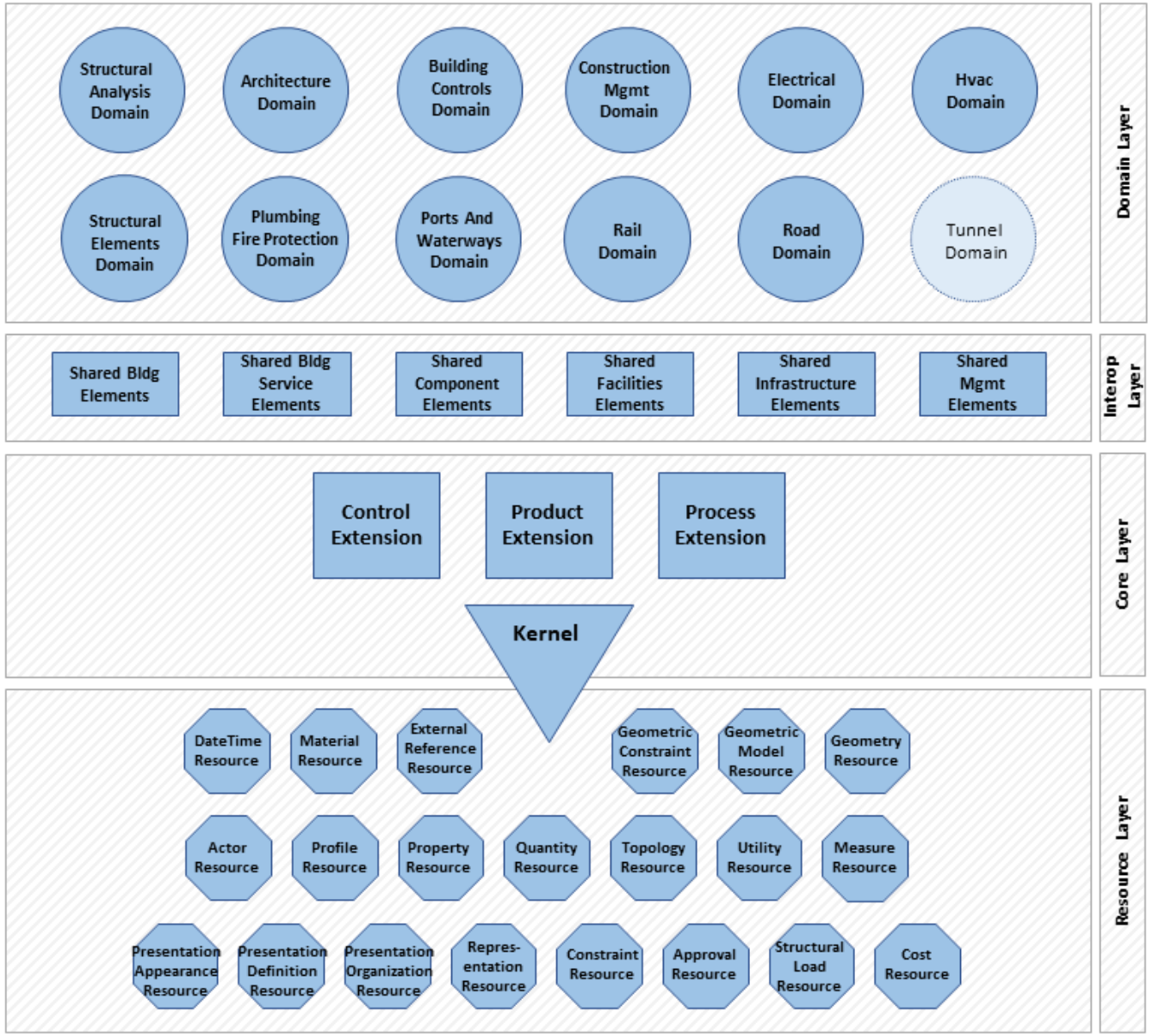
8.1 IfcActorResource
8.2 IfcApprovalResource
8.3 IfcConstraintResource
8.4 IfcCostResource
8.5 IfcDateTimeResource
8.6 IfcExternalReferenceResource
8.7 IfcGeometricConstraintResource
8.8 IfcGeometricModelResource
8.9 IfcGeometryResource
8.10 IfcMaterialResource
8.11 IfcMeasureResource



Industry Foundation Classes version 4.3.x Architecture overview

8.12 IfcPresentationAppearanceResource
8.13 IfcPresentationDefinitionResource
8.14 IfcPresentationOrganizationResource
8.15 IfcProfileResource
8.16 IfcPropertyResource
8.17 IfcQuantityResource
8.18 IfcRepresentationResource
8.19 IfcStructuralLoadResource
8.20 IfcTopologyResource
8.21 IfcUtilityResource

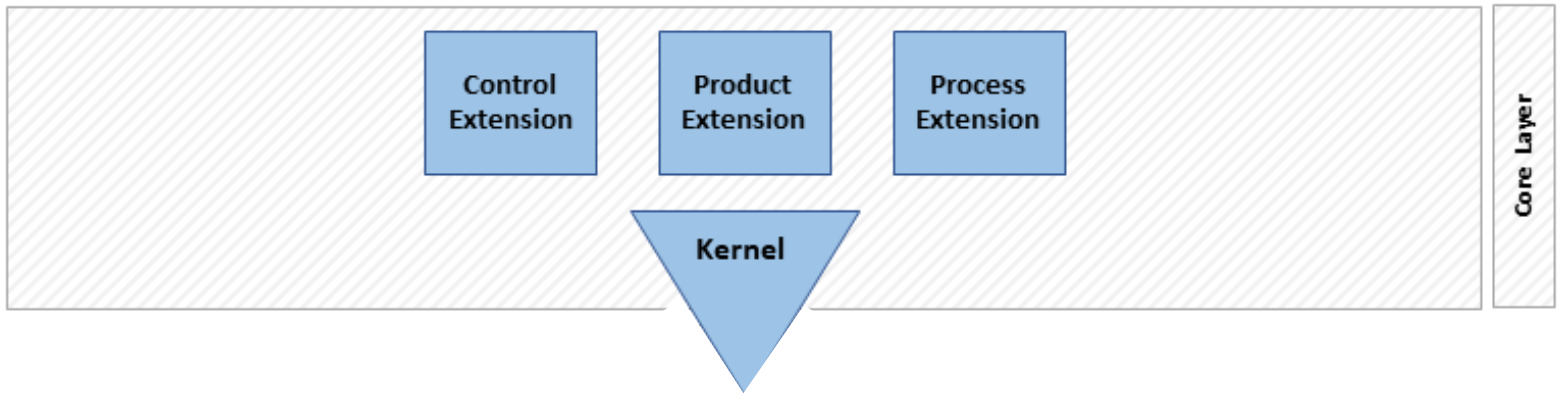
IFC Architecture – 4.3



Industry Foundation Classes version 4.3.x Architecture overview

IFC Architecture – 4.3 – Core layer

- Contains entities that represent abstract concepts that will be used to define entities in the upper layers;
- The kernel SCHEMA defines key concepts such as actor, group, process, group, relationship, etc.



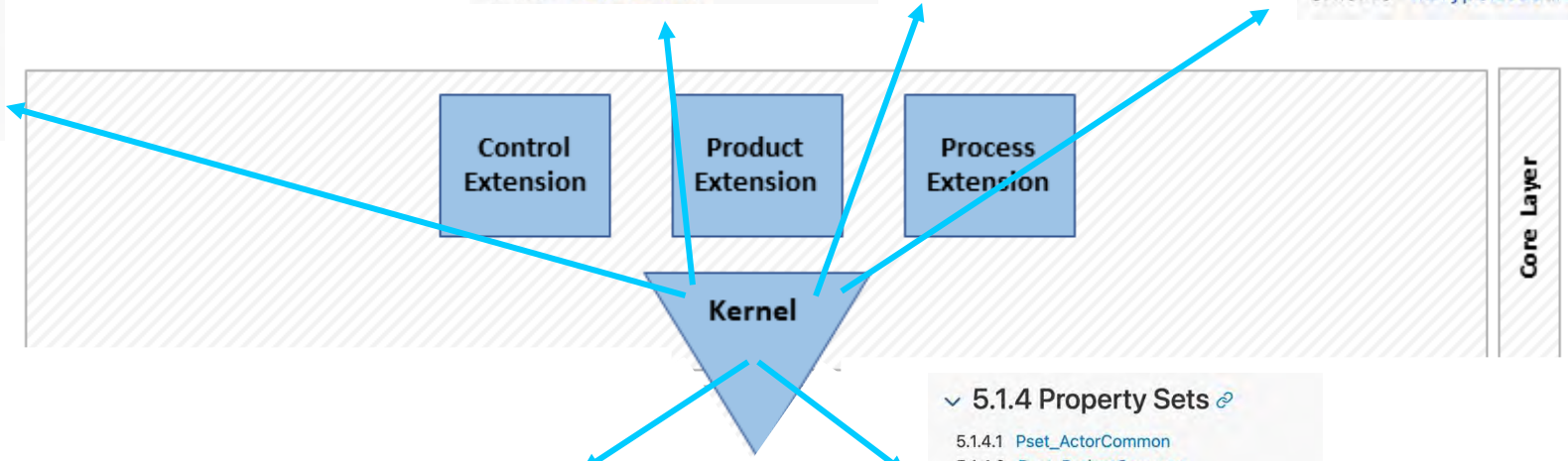
- The “Product Extension” SCHEMA defines abstract building components as space, location, element, annotation;
- The other two SCHEMAS Extensions define: tasks, procedures, scheduling, approvals (process and control).

IFC Architecture – 4.3 – Core layer

5.1.3.1 IfcActor
5.1.3.2 IfcComplexPropertyTemplate
5.1.3.3 IfcContext
5.1.3.4 IfcControl
5.1.3.5 IfcGroup
5.1.3.6 IfcObject
5.1.3.7 IfcObjectDefinition
5.1.3.8 IfcPreDefinedPropertySet
5.1.3.9 IfcProcess
5.1.3.10 IfcProduct
5.1.3.11 IfcProject
5.1.3.12 IfcProjectLibrary
5.1.3.13 IfcPropertyDefinition
5.1.3.14 IfcPropertySet
5.1.3.15 IfcPropertySetDefinition
5.1.3.16 IfcPropertySetTemplate
5.1.3.17 IfcPropertyTemplate

5.1.3.18 IfcPropertyTemplateDefinition
5.1.3.19 IfcQuantitySet
5.1.3.20 IfcRelAggregates
5.1.3.21 IfcRelAssigns
5.1.3.22 IfcRelAssignsToActor
5.1.3.23 IfcRelAssignsToControl
5.1.3.24 IfcRelAssignsToGroup
5.1.3.25 IfcRelAssignsToGroupByFactor
5.1.3.26 IfcRelAssignsToProcess
5.1.3.27 IfcRelAssignsToProduct
5.1.3.28 IfcRelAssignsToResource
5.1.3.29 IfcRelAssociates
5.1.3.30 IfcRelAssociatesClassification
5.1.3.31 IfcRelAssociatesDocument
5.1.3.32 IfcRelAssociatesLibrary
5.1.3.33 IfcRelConnects
5.1.3.34 IfcRelDeclares

5.1.3.35 IfcRelDecomposes
5.1.3.36 IfcRelDefines
5.1.3.37 IfcRelDefinesByObject
5.1.3.38 IfcRelDefinesByProperties
5.1.3.39 IfcRelDefinesByTemplate
5.1.3.40 IfcRelDefinesByType
5.1.3.41 IfcRelNests
5.1.3.42 IfcRelationship
5.1.3.43 IfcResource
5.1.3.44 IfcRoot
5.1.3.45 IfcSimplePropertyTemplate
5.1.3.46 IfcTypeObject
5.1.3.47 IfcTypeProcess
5.1.3.48 IfcTypeProduct
5.1.3.49 IfcTypeResource



5.1.7 Rules
5.1.7.1 IfcSingleProjectInstance

5.1.8 PropertyEnumerations
5.1.8.1 PEnum_ProjectType

5.1.4 Property Sets
5.1.4.1 Pset_ActorCommon
5.1.4.2 Pset_ProjectCommon

5.1.5 Quantity Sets
5.1.5.1 Qto_BodyGeometryValidation

5.1.6 Functions
5.1.6.1 IfcUniqueDefinitionNames
5.1.6.2 IfcUniquePropertyName
5.1.6.3 IfcUniquePropertySetNames
5.1.6.4 IfcUniquePropertyTemplateNames

IFC Architecture – 4.3 – Core layer

5.2.2 Types

5.2.2.1 IfcPerformanceHistoryTypeEnum

5.2.3 Entities

5.2.3.1 IfcPerformanceHistory
5.2.3.2 IfcRelAssociatesApproval
5.2.3.3 IfcRelAssociatesConstraint

5.3.2 Types

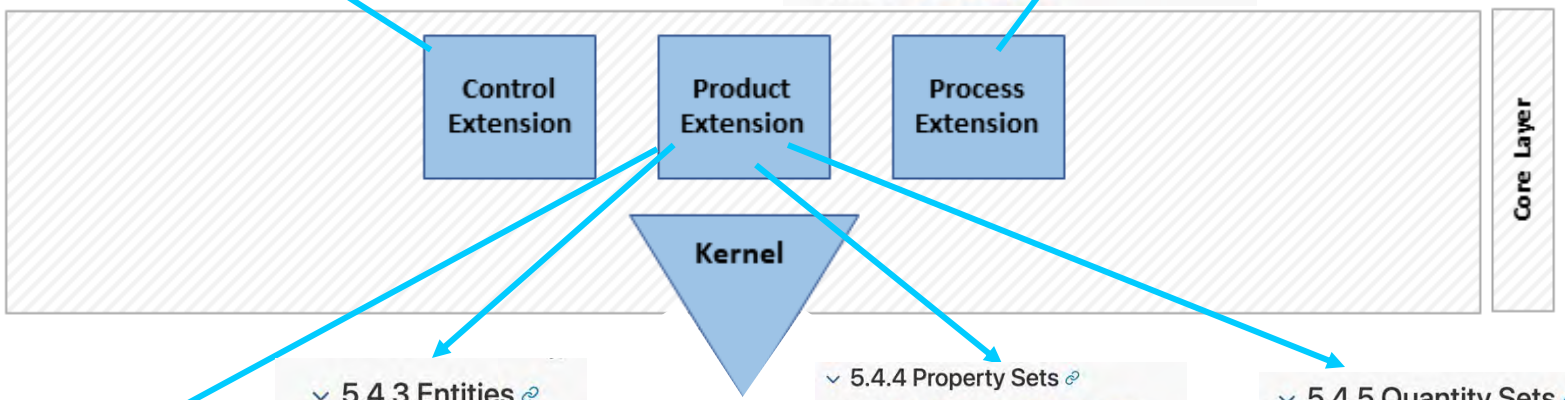
5.3.2.1 IfcEventTriggerTypeEnum
5.3.2.2 IfcEventTypeEnum
5.3.2.3 IfcProcedureTypeEnum
5.3.2.4 IfcSequenceEnum
5.3.2.5 IfcTaskTypeEnum
5.3.2.6 IfcWorkCalendarTypeEnum
5.3.2.7 IfcWorkPlanTypeEnum
5.3.2.8 IfcWorkScheduleTypeEnum

5.3.3 Entities

5.3.3.1 IfcEvent
5.3.3.2 IfcEventType
5.3.3.3 IfcProcedure
5.3.3.4 IfcProcedureType
5.3.3.5 IfcRelSequence
5.3.3.6 IfcTask
5.3.3.7 IfcTaskType
5.3.3.8 IfcWorkCalendar
5.3.3.9 IfcWorkControl
5.3.3.10 IfcWorkPlan
5.3.3.11 IfcWorkSchedule

5.3.4 Property Sets

5.3.4.1 Pset_WorkControlCommon



5.4.2 Types

5.4.2.1 IfcAlignmentTypeEnum
5.4.2.2 IfcAnnotationTypeEnum
5.4.2.3 IfcAssemblyPlaceEnum
5.4.2.4 IfcBridgePartTypeEnum
5.4.2.5 IfcBridgeTypeEnum
5.4.2.6 IfcBuiltSystemTypeEnum
5.4.2.7 IfcElementAssemblyTypeEnum

(…)

5.4.3 Entities

5.4.3.1 IfcAlignment
5.4.3.2 IfcAlignmentCant
5.4.3.3 IfcAlignmentHorizontal
5.4.3.4 IfcAlignmentSegment
5.4.3.5 IfcAlignmentVertical
5.4.3.6 IfcAnnotation
5.4.3.7 IfcBridge
5.4.3.8 IfcBridgePart
5.4.3.9 IfcBuilding

(…)

5.4.4 Property Sets

5.4.4.1 Pset_AlignmentCantSegmentCommon
5.4.4.2 Pset_AlignmentVerticalSegmentCommon
5.4.4.3 Pset_AnnotationContourLine
5.4.4.4 Pset_AnnotationLineOfSight
5.4.4.5 Pset_AnnotationSurveyArea
5.4.4.6 Pset_BridgeCommon
5.4.4.7 Pset_BuildingCommon
5.4.4.8 Pset_BuildingStoreyCommon
5.4.4.9 Pset_BuildingUse
5.4.4.10 Pset_BuildingUseAdjacent
5.4.4.11 Pset_CivilElementCommon
5.4.4.12 Pset_ElementAssemblyCommon

(…)

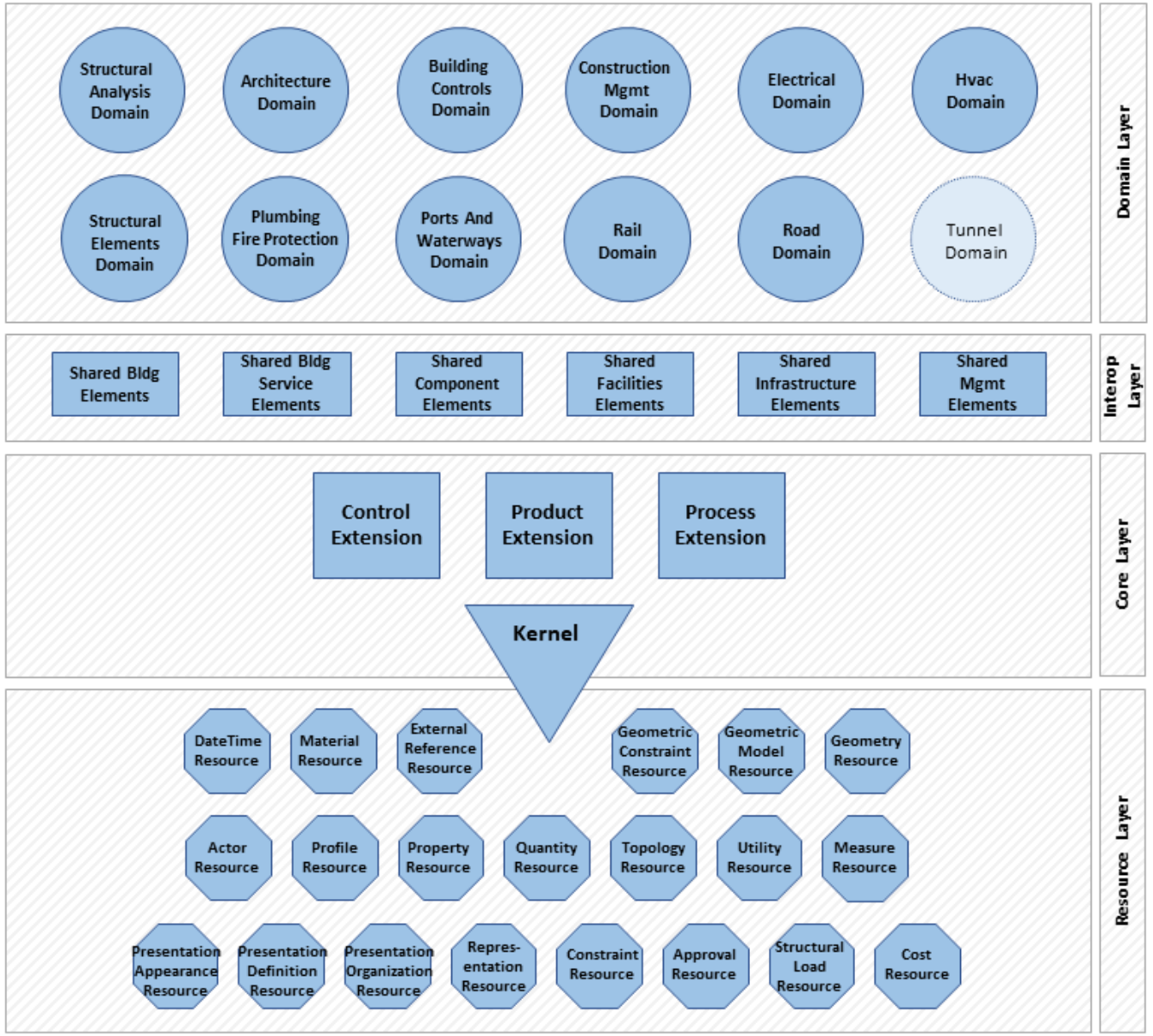
5.4.5 Quantity Sets

5.4.5.1 Qto_BuildingBaseQuantities
5.4.5.2 Qto_BuildingStoreyBaseQuantities
5.4.5.3 Qto_OpeningElementBaseQuantities
5.4.5.4 Qto_ProjectionElementBaseQuantities
5.4.5.5 Qto_SiteBaseQuantities
5.4.5.6 Qto_SpaceBaseQuantities

5.4.8 PropertyEnumerations

5.4.8.1 PEnum_AcquisitionMethod
5.4.8.2 PEnum_LifeCyclePhase
5.4.8.3 PEnum_ProcessItem

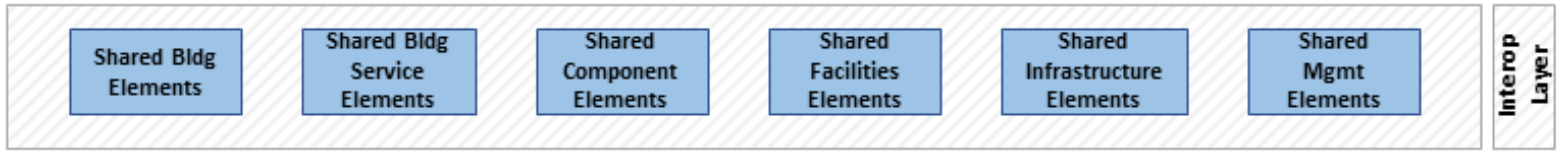
IFC Architecture – 4.3



Industry Foundation Classes version 4.3.x Architecture overview

IFC Architecture – 4.3 – Interoperability layer

The shared element data schemas contain intermediate specializations of entities. Entities defined in this layer can be referenced and specialized by all entities above in the hierarchy. The shared element layer provides more specialized objects and relationships shared by multiple domains.



“Shared Building Elements” - definition of entities for beam, column, door, etc.

“Shared Building Services Elements” - definition of fluid flow properties, acoustic properties, etc.

“Shared Facilities Elements” - definition of entities for goods, occupants, furniture, etc…

…

IFC Architecture – 4.3 – Interoperability layer

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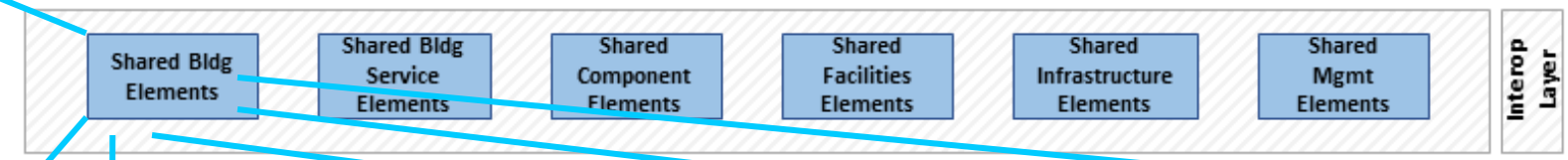
6.1.8 PropertyEnumerations

6.1.8.1 PEnum_AdjustmentValueType
6.1.8.2 PEnum_AssemblyPlace
6.1.8.3 PEnum_AssetRating
6.1.8.4 PEnum_BackInletPatternType
6.1.8.5 PEnum_ConductorFunctionEnum
6.1.8.6 PEnum_DataCollectionType
6.1.8.7 PEnum_ElementShading
6.1.8.8 PEnum_ElementStatus
6.1.8.9 PEnum_EndShapeType
6.1.8.10 PEnum_EnergySource
6.1.8.11 PEnum_FiberColour
6.1.8.12 PEnum_FiberType
6.1.8.13 PEnum_FireDamperActuationType
6.1.8.14 PEnum_FireDamperClosureRating

(…)

6.1.2 Types

6.1.2.1 IfcBeamTypeEnum
6.1.2.2 IfcBearingTypeEnum
6.1.2.3 IfcBuildingElementProxyTypeEnum
6.1.2.4 IfcBuildingSystemTypeEnum
6.1.2.5 IfcChimneyTypeEnum
6.1.2.6 IfcColumnTypeEnum
6.1.2.7 IfcConnectionTypeEnum
6.1.2.8 IfcCoveringTypeEnum
6.1.2.9 IfcCurtainWallTypeEnum
6.1.2.10 IfcDoorTypeEnum
6.1.2.11 IfcDoorTypeOperationEnum
6.1.2.12 IfcMemberTypeEnum
6.1.2.13 IfcPlateTypeEnum
6.1.2.14 IfcRailingTypeEnum
6.1.2.15 IfcRampFlightTypeEnum
6.1.2.16 IfcRampTypeEnum
6.1.2.17 IfcRoofTypeEnum
6.1.2.18 IfcShadingDeviceTypeEnum
6.1.2.19 IfcSlabTypeEnum
6.1.2.20 IfcStairFlightTypeEnum
6.1.2.21 IfcStairTypeEnum
6.1.2.22 IfcWallTypeEnum



6.1.3 Entities

6.1.3.1 IfcBeam
6.1.3.2 IfcBeamType
6.1.3.3 IfcBearing
6.1.3.4 IfcBearingType
6.1.3.5 IfcBuildingElementProxy
6.1.3.6 IfcBuildingElementProxyType
6.1.3.7 IfcBuildingSystem
6.1.3.8 IfcChimney
6.1.3.9 IfcChimneyType
6.1.3.10 IfcColumn
6.1.3.11 IfcColumnType
6.1.3.12 IfcCovering
6.1.3.13 IfcCoveringType
6.1.3.14 IfcCurtainWall
6.1.3.15 IfcCurtainWallType
6.1.3.16 IfcDoor
6.1.3.17 IfcDoorType
6.1.3.18 IfcMember
6.1.3.19 IfcMemberType
6.1.3.20 IfcPlate
6.1.3.21 IfcPlateType
6.1.3.22 IfcRailing
6.1.3.23 IfcRailingType
6.1.3.24 IfcRamp
6.1.3.25 IfcRampFlight
6.1.3.26 IfcRampFlightType
6.1.3.27 IfcRampType
6.1.3.28 IfcRelConnectsPathElements
6.1.3.29 IfcRelCoversBldgElements
6.1.3.30 IfcRelCoversSpaces
6.1.3.31 IfcRoof
6.1.3.32 IfcRoofType
6.1.3.33 IfcShadingDevice
6.1.3.34 IfcShadingDeviceType
6.1.3.35 IfcSlab
6.1.3.36 IfcSlabType
6.1.3.37 IfcStair
6.1.3.38 IfcStairFlight
6.1.3.39 IfcStairFlightType
6.1.3.40 IfcStairType
6.1.3.41 IfcWall
6.1.3.42 IfcWallStandardCase
6.1.3.43 IfcWallType
6.1.3.44 IfcWindow
6.1.3.45 IfcWindowType

6.1.4 Property Sets

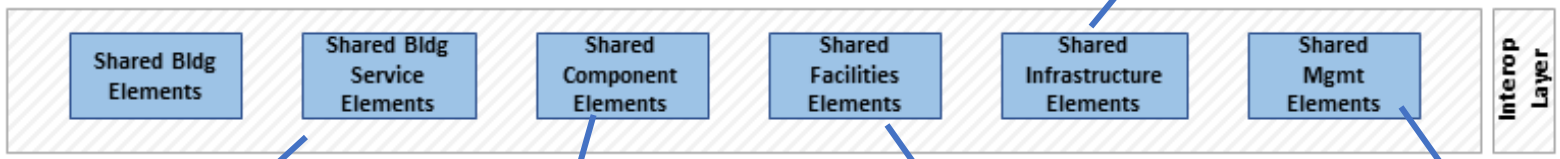
6.1.4.1 Pset_BeamCommon
6.1.4.2 Pset_BearingCommon
6.1.4.3 Pset_BuildingElementProxyCommon
6.1.4.4 Pset_BuildingSystemCommon
6.1.4.5 Pset_ChimneyCommon
6.1.4.6 Pset_ColumnCommon
6.1.4.7 Pset_CoveringCommon
6.1.4.8 Pset_CoveringFlooring
6.1.4.9 Pset_CurtainWallCommon
6.1.4.10 Pset_DoorCommon
6.1.4.11 Pset_DoorWindowGlazingType
6.1.4.12 Pset_MemberCommon
6.1.4.13 Pset_PlateCommon
6.1.4.14 Pset_RailingCommon
6.1.4.15 Pset_RampCommon
6.1.4.16 Pset_RampFlightCommon
6.1.4.17 Pset_RoofCommon
6.1.4.18 Pset_ShadingDeviceCommon
6.1.4.19 Pset_SlabCommon
6.1.4.20 Pset_StairCommon
6.1.4.21 Pset_StairFlightCommon
6.1.4.22 Pset_Tiling
6.1.4.23 Pset_WallCommon
6.1.4.24 Pset_WindowCommon

6.1.5 Quantity Sets

6.1.5.1 Qto_BeamBaseQuantities
6.1.5.2 Qto_BuildingElementProxyQuantities
6.1.5.3 Qto_ChimneyBaseQuantities
6.1.5.4 Qto_ColumnBaseQuantities
6.1.5.5 Qto_CoveringBaseQuantities
6.1.5.6 Qto_CurtainWallQuantities
6.1.5.7 Qto_DoorBaseQuantities
6.1.5.8 Qto_MemberBaseQuantities
6.1.5.9 Qto_PlateBaseQuantities
6.1.5.10 Qto_RailingBaseQuantities
6.1.5.11 Qto_RampFlightBaseQuantities
6.1.5.12 Qto_RoofBaseQuantities
6.1.5.13 Qto_SlabBaseQuantities
6.1.5.14 Qto_StairFlightBaseQuantities
6.1.5.15 Qto_WallBaseQuantities
6.1.5.16 Qto_WindowBaseQuantities

IFC Architecture – 4.3 Interoperability layer

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6.2.3 Entities

6.2.3.1 IfcDistributionChamberElement
6.2.3.2 IfcDistributionChamberElementType
6.2.3.3 IfcDistributionCircuit
6.2.3.4 IfcDistributionControlElement
6.2.3.5 IfcDistributionControlElementType
6.2.3.6 IfcDistributionFlowElement
6.2.3.7 IfcDistributionFlowElementType
6.2.3.8 IfcDistributionPort
6.2.3.9 IfcDistributionSystem
6.2.3.10 IfcEnergyConversionDevice
6.2.3.11 IfcEnergyConversionDeviceType
6.2.3.12 IfcFlowController
6.2.3.13 IfcFlowControllerType

(…)

(…)

6.3.3 Entities

6.3.3.1 IfcBuildingElementPart
6.3.3.2 IfcBuildingElementPartType
6.3.3.3 IfcDiscreteAccessory
6.3.3.4 IfcDiscreteAccessoryType
6.3.3.5 IfcElementComponent
6.3.3.6 IfcElementComponentType
6.3.3.7 IfcFastener
6.3.3.8 IfcFastenerType
6.3.3.9 IfcMechanicalFastener
6.3.3.10 IfcMechanicalFastenerType

(…)

(…)

6.4.3 Entities

6.4.3.1 IfcAsset
6.4.3.2 IfcFurniture
6.4.3.3 IfcFurnitureType
6.4.3.4 IfcInventory
6.4.3.5 IfcOccupant
6.4.3.6 IfcSystemFurnitureElement
6.4.3.7 IfcSystemFurnitureElementType

6.4.4 Property Sets

6.4.4.1 Pset_Asset
6.4.4.2 Pset_Condition
6.4.4.3 Pset_ConstructionAdministration
6.4.4.4 Pset_ConstructionOccurence
6.4.4.5 Pset_FurnitureTypeChair

(…)

(…)

6.5.3 Entities

6.5.3.1 IfcActionRequest
6.5.3.2 IfcCostItem
6.5.3.3 IfcCostSchedule
6.5.3.4 IfcPermit
6.5.3.5 IfcProjectOrder

6.5.4 Property Sets

6.5.4.1 Pset_ActionRequest
6.5.4.2 Pset_PackingInstructions
6.5.4.3 Pset_Permit

(…)

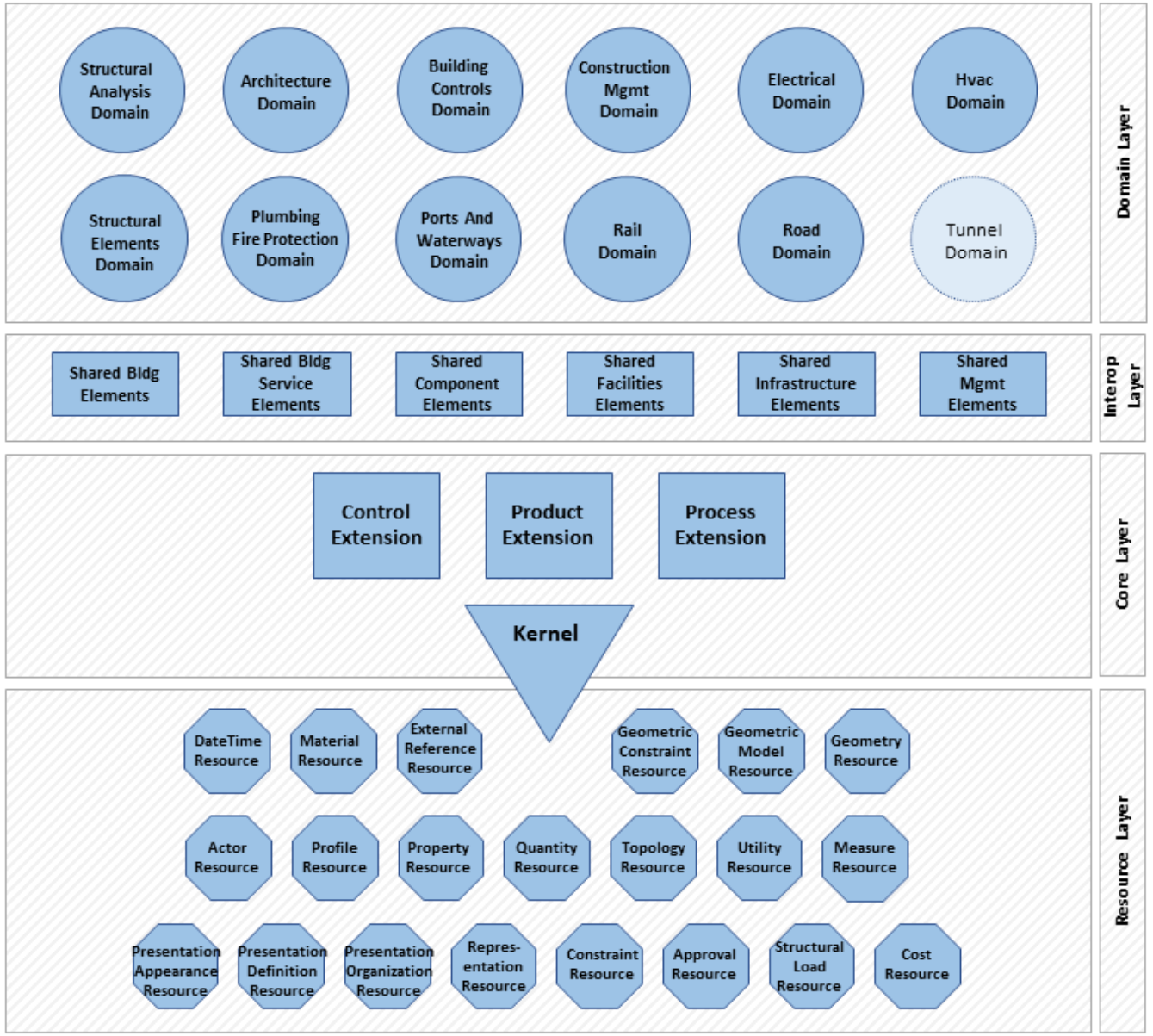
(…)

6.6.3 Entities

6.6.3.1 IfcBorehole
6.6.3.2 IfcCourse
6.6.3.3 IfcCourseType
6.6.3.4 IfcEarthworksCut
6.6.3.5 IfcEarthworksElement
6.6.3.6 IfcEarthworksFill
6.6.3.7 IfcGeomodel
6.6.3.8 IfcGeoslice
6.6.3.9 IfcGeotechnicalAssembly
6.6.3.10 IfcGeotechnicalElement

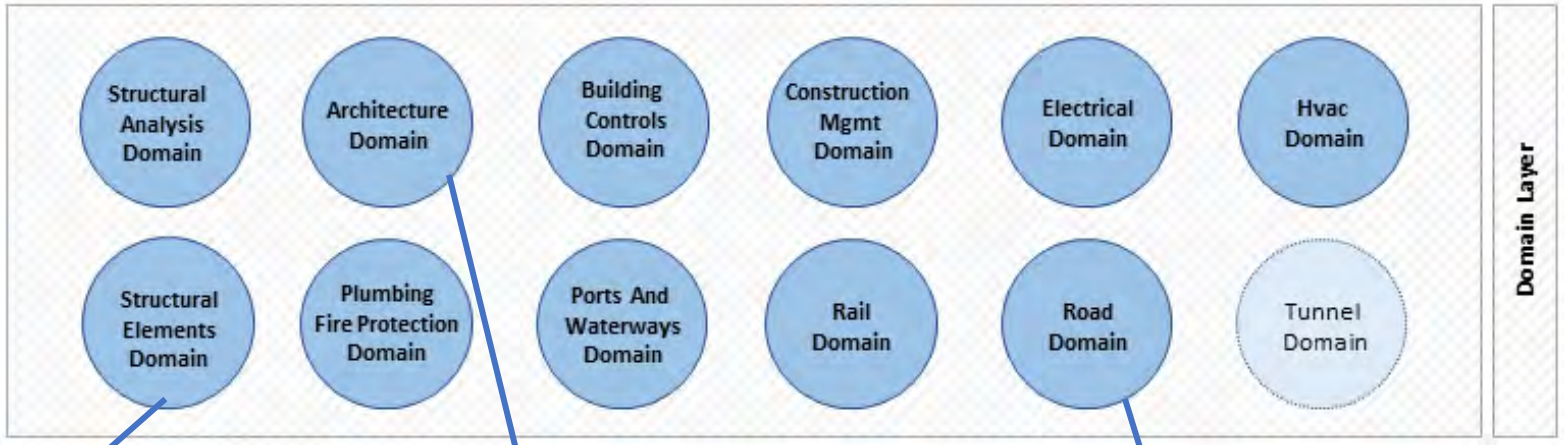
(…)

IFC Architecture – 4.3



Industry Foundation Classes version 4.3.x Architecture overview

IFC Arch. 4.3 Domain layer



7.11.3 Entities

- 7.11.3.1 IfcCaissonFoundation
- 7.11.3.2 IfcCaissonFoundationType
- 7.11.3.3 IfcDeepFoundation
- 7.11.3.4 IfcDeepFoundationType
- 7.11.3.5 IfcFooting
- 7.11.3.6 IfcFootingType
- 7.11.3.7 IfcPile
- 7.11.3.8 IfcPileType
- 7.11.3.9 IfcReinforcementDefinitionProperties
- 7.11.3.10 IfcReinforcingBar
- 7.11.3.11 IfcReinforcingBarType
- 7.11.3.12 IfcReinforcingElement
- 7.11.3.13 IfcReinforcingElementType

7.1.2 Types

- 7.1.2.1 IfcDoorPanelOperationEnum
- 7.1.2.2 IfcDoorPanelPositionEnum
- 7.1.2.3 IfcPermeableCoveringOperationEnum
- 7.1.2.4 IfcWindowPanelOperationEnum
- 7.1.2.5 IfcWindowPanelPositionEnum

7.1.3 Entities

- 7.1.3.1 IfcDoorLiningProperties
- 7.1.3.2 IfcDoorPanelProperties
- 7.1.3.3 IfcPermeableCoveringProperties
- 7.1.3.4 IfcWindowLiningProperties
- 7.1.3.5 IfcWindowPanelProperties

7.1.4 Property Sets

- 7.1.4.1 Pset_DoorLiningProperties
- 7.1.4.2 Pset_DoorPanelProperties
- 7.1.4.3 Pset_PermeableCoveringProperties
- 7.1.4.4 Pset_WindowLiningProperties
- 7.1.4.5 Pset_WindowPanelProperties

7.8.3 Entities

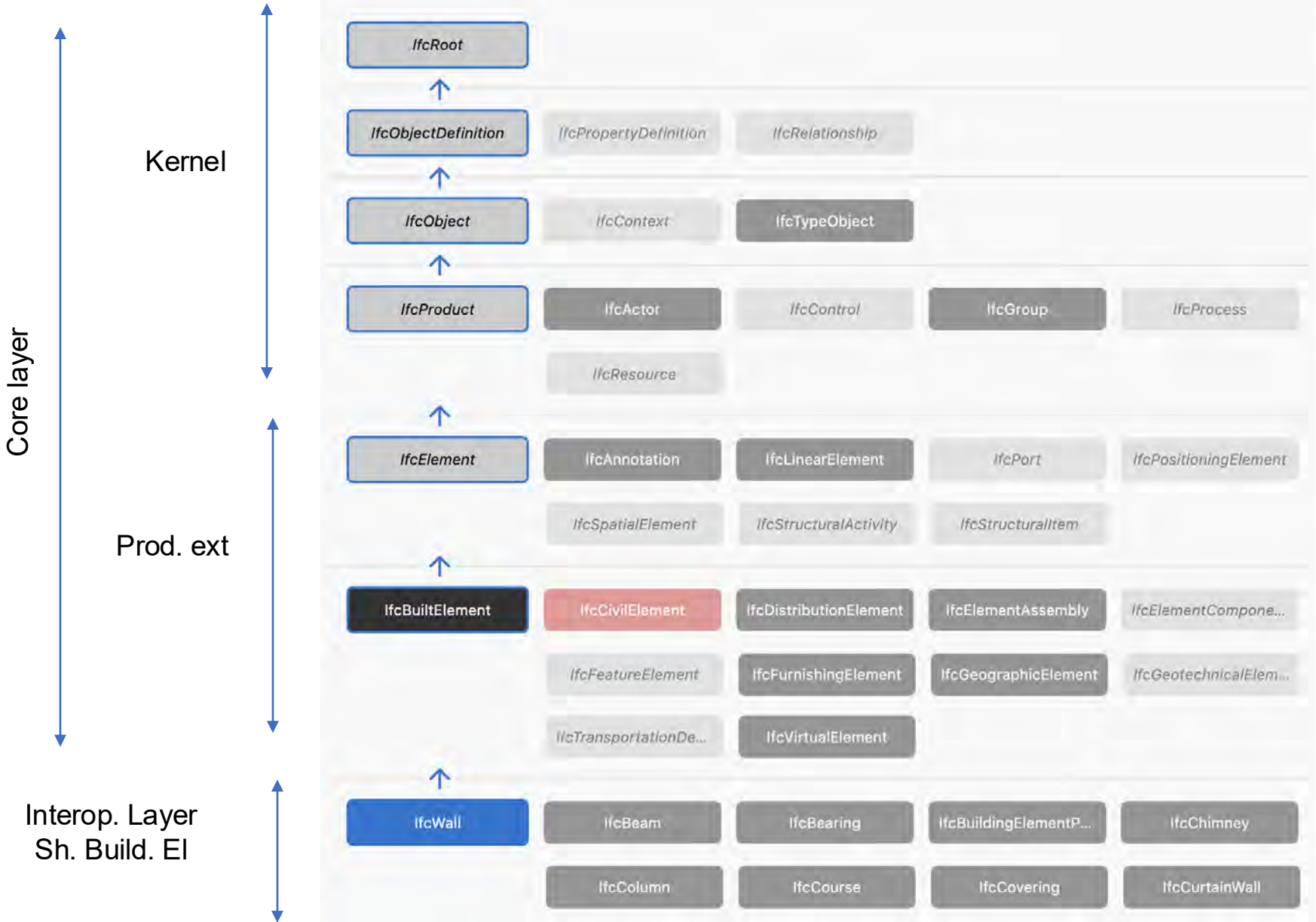
- 7.8.3.1 IfcRail
- 7.8.3.2 IfcRailType
- 7.8.3.3 IfcRailway
- 7.8.3.4 IfcRailwayPart
- 7.8.3.5 IfcTrackElement
- 7.8.3.6 IfcTrackElementType

7.8.4 Property Sets

- 7.8.4.1 Pset_AudioVisualApplianceTypeRailwayCommunicationTerminal
- 7.8.4.2 Pset_AudioVisualApplianceTypeRecordingEquipment
- 7.8.4.3 Pset_AxleCountingEquipment
- 7.8.4.4 Pset_BalanceWeightTensionerDesignCriteria
- 7.8.4.5 Pset_BuiltSystemRailwayLine
- 7.8.4.6 Pset_BuiltSystemRailwayTrack
- 7.8.4.7 Pset_CableCarrierSegmentTypeCatenaryWire
- 7.8.4.8 Pset_CableCarrierSegmentTypeDropper
- 7.8.4.9 Pset_CableFittingTypeExit
- 7.8.4.10 Pset_CableFittingTypeFanout

Highest level of IFC model, containing definitions of concepts specific to individual domains such as Architecture, Structural Eng, etc.

Inheritance - IfcWall example

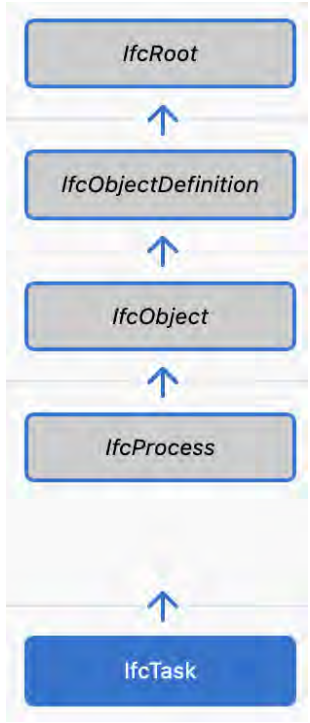


Inheritance - some examples

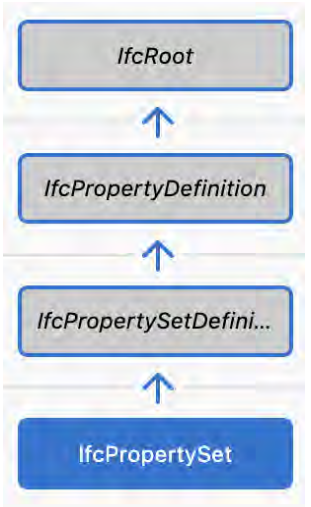


Inheritance - more examples

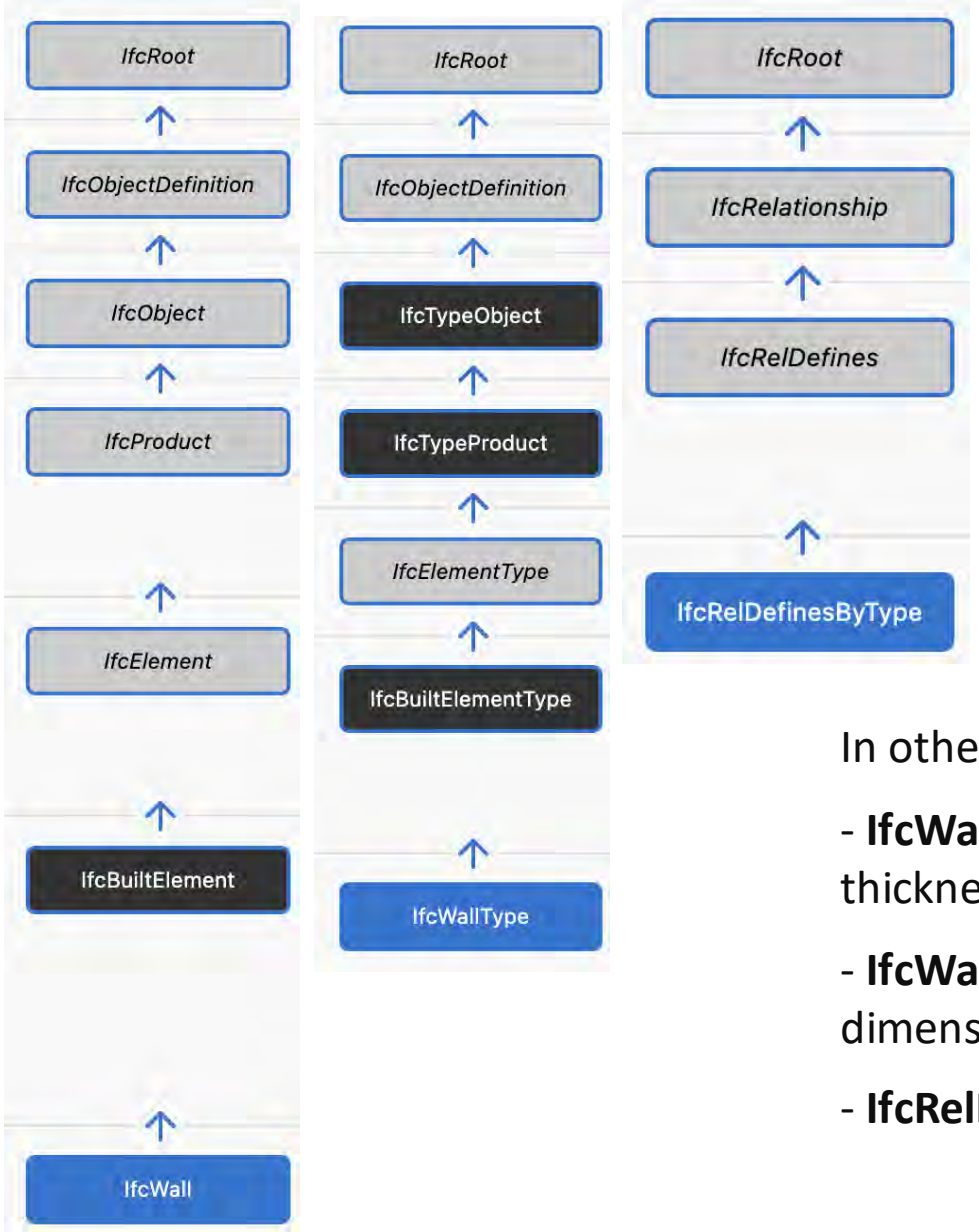








Types - object classes in IFC



- There is a definition of the wall class 'IfcWallType' in the model, with properties, characteristics for a certain type of wall.
- There is an instance of a wall in a model. It has a 'physical' expression (it is an 'IfcWall' instance in the model)
- The two are related by an IfcRelDefinesbyType entity.

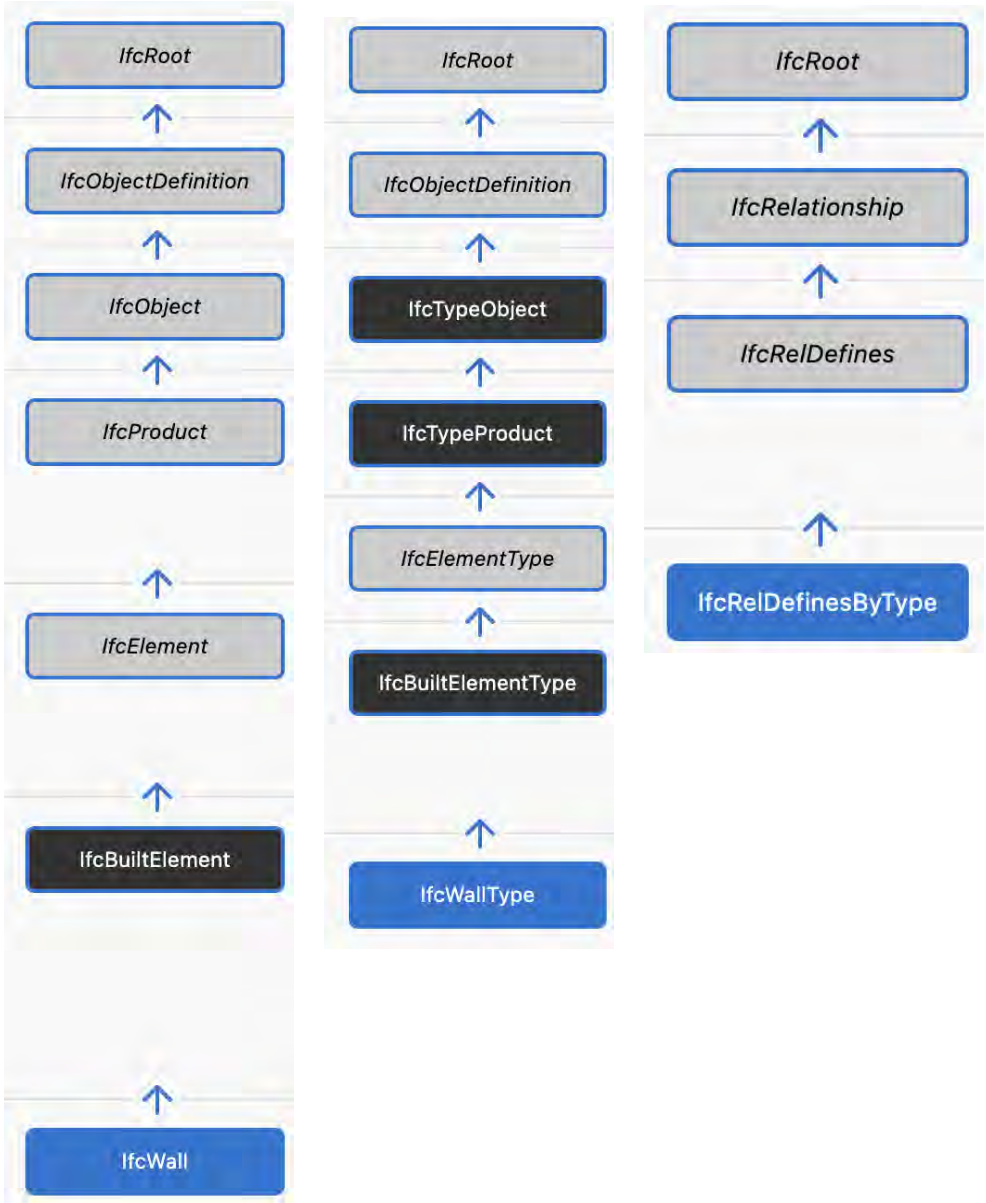
In other words:

- **IfcWallType:** 'Brick Exterior Wall' (define material = brick, thickness = 200 mm).

- **IfcWall:** A specific instance of the wall (can override dimensions or other specific characteristics of the instance).

- **IfcRelDefinesByType:** links the two.

Types - object classes in IFC



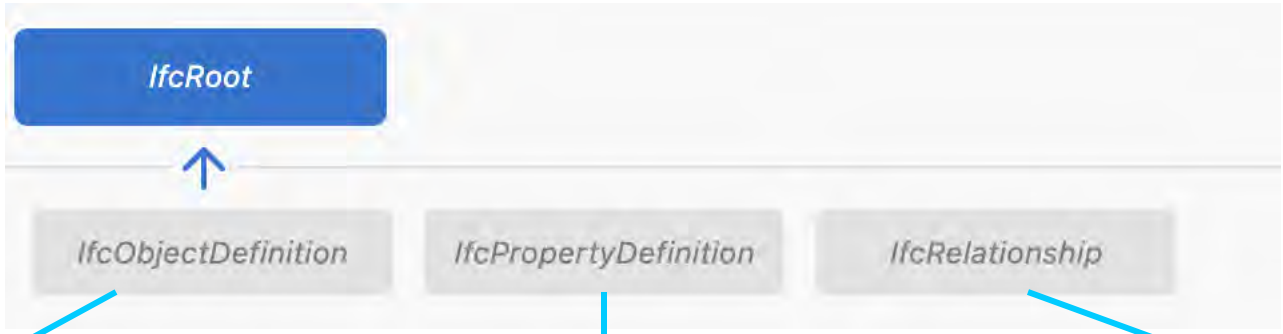
How IfcWallType Replaces Properties in IfcWall

- **Property Sets (Psets):** Both IfcWallType and IfcWall can have property sets.
- The IfcWallType defines **standard properties** shared by all associated IfcWall instances.
- The IfcWall can **override** specific properties for customisation.

Practical Example:

- The IfcWallType defines:
  - Material: Brick
  - Fire Resistance: 120 minutes
  - Thermal Transmission: 0.45 W/m²K
- IfcWall inherits these properties, but replaces them:
  - Fire Resistance: 90 minutes (specific to this wall instance).

The beginning of all inheritance trees, the IFCRoot



The **IfcObjectDefinition** includes entities that represent physical objects, abstract concepts or processes.

- **Examples of physical objects:** walls (**IfcWall**), doors (**IfcDoor**).
- **Examples of abstract or procedural objects:** spaces (**IfcSpace**), tasks (**IfcTask**), systems (**IfcSystem**).

These objects can be aggregated, contained in spatial hierarchies or related to other elements.

IfcPropertyDefinition allows you to define properties, grouped into sets (**IfcPropertySet**) or isolated (**IfcPropertySingleValue**).

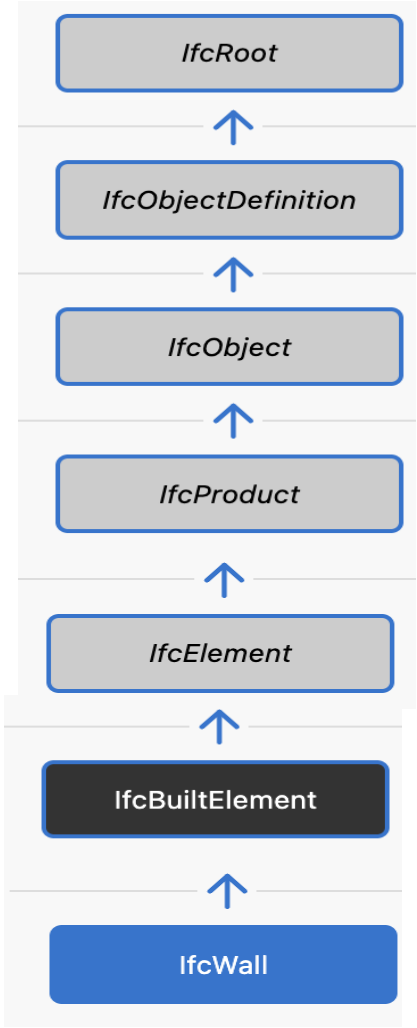
- Properties can describe characteristics such as materials, dimensions or performance.
- **Property Sets (Psets):** group together multiple related properties, such as 'Pset_WallCommon'.

This structure guarantees consistency in assigning and reusing information about objects.

IfcRelationship defines how objects and other elements are interconnected. It is the basis for modelling connections in IFC.

- **Relating types and instances:** for example, an **IfcWall** linked to an **IfcWallType** via **IfcRelDefinesByType**.
- **Relate properties**: link property sets (**IfcPropertySet**) to instances or types via **IfcRelDefinesByProperties**.
- Other relationships include spatial hierarchies (**IfcRelContainedInSpatialStructure**) or physical connections (**IfcRelConnectsElements**).

Inheritance - IfcWall example



IfcRoot **is the most abstract and root class for all entity definitions** that roots in the kernel or in subsequent layers of the IFC specification. It is therefore the common supertype of all IFC entities, beside those defined in an IFC resource schema

An ***IfcObjectDefinition*** is the generalization of any semantically treated thing or process, either being a type or an occurrences. Object defintions can be named, using the inherited Name attribute, which should be a user recognizable label for the object occurrance. **There are four essential relationship definitions: (i) Assignment of other objects; (ii) Association to external resources; (iii) Aggregation of other objects; (iv) Nesting of other objects.**

An ***IfcObject*** is the generalization of any semantically treated thing or process. Objects are things as they appear - i.e. occurrences. **Examples of IfcObject include physically tangible items such as wall, beam or covering, physically existing items such as spaces, or conceptual items such as grids or virtual boundaries.**

The ***IfcProduct*** is **an abstract representation of any object that relates to a geometric or spatial context.** An IfcProduct occurs at a specific location in space if it has a geometric representation assigned. It can be placed relatively to other products, but ultimately relative to the project coordinate system.

IfcElement is a **generalization of all components that make up an AEC product.**
Elements are physically existent objects, although they might be void elements, such as holes. Elements either remain permanently in the AEC product, or only temporarily, as formwork does. Elements can be either assembled on site or pre-manufactured and built in on site. **Examples of elements in a building construction context are walls, floors, windows and recesses.**

The ***IfcBuildingElement*** comprises all elements that are primarily part of the construction of a built facility, i.e., its structural and space separating system. **Building elements are all physically existent and tangible things. Major functional part of a building, examples are foundation, floor, roof, wall.**

IfcWall **represents a vertical construction that may bound or subdivide spaces**. Wall are usually vertical, or nearly vertical, planar elements, often designed to bear structural loads. A wall is however not required to be load bearing.

5.1.3.44 IfcRoot

ABSTRACT This definition may not be instantiated

5.1.3.44.1 Semantic definition

IfcRoot is the most abstract and root class for all entity definitions that roots in the kernel or in subsequent layers of the IFC specification. It is therefore the common supertype of all IFC entities, beside those defined in an IFC resource schema. All entities that are subtypes of *IfcRoot* can be used independently, whereas resource schema entities, that are not subtypes of *IfcRoot*, are not supposed to be independent entities.

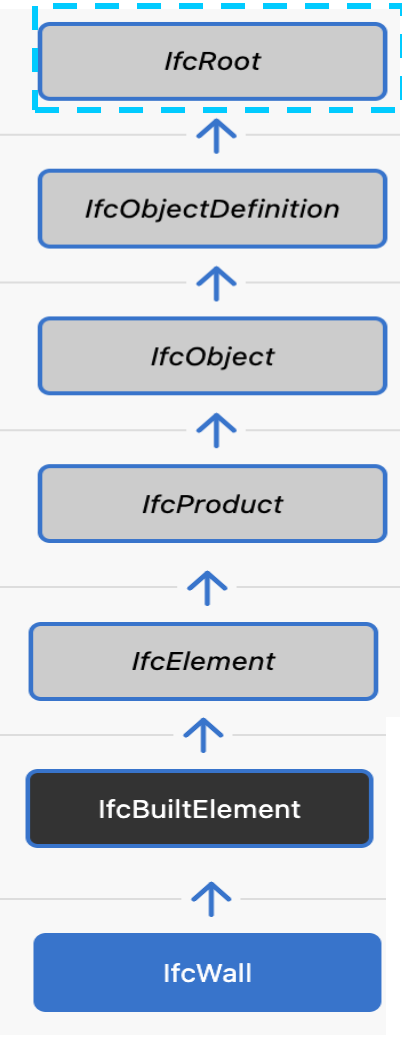
5.1.3.44.2 Entity inheritance



5.1.3.44.3 Attributes

#	Attribute	Type	Description
IfcRoot (4)			
1	GlobalId	IfcGloballyUniqueId	Assignment of a globally unique identifier within the entire software world.
2	OwnerHistory	OPTIONAL IfcOwnerHistory	Assignment of the information about the current ownership of that object, including owning actor, application, local identification and information captured about the recent changes of the object, NOTE Only the last modification is stored – either as addition, deletion or modification. IFC4-CHANGE The attribute has been changed to be OPTIONAL.
3	Name	OPTIONAL IfcLabel	Optional name for use by the participating software systems or users. For some subtypes of IfcRoot the insertion of the Name attribute may be required. This would be enforced by a where rule.
4	Description	OPTIONAL IfcText	Optional description, provided for exchanging informative comments.

They are numbered. They will be explicit attributes in STEP (file.ifc).



IfcRoot

5.1.3.44.4 Formal propositions

Name	Description
UR1	The attribute GlobalId should be unique

Table 5.1.3.44.B

5.1.3.44.5 Concept usage

Concept	Usage	Description
IfcRoot (2)		
Revision Control	General	Ownership, history, and merge state is captured using IfcOwnerHistory.
Software Identity	General	IfcRoot assigns the globally unique ID. In addition it may provide for a name and a description about the concept.

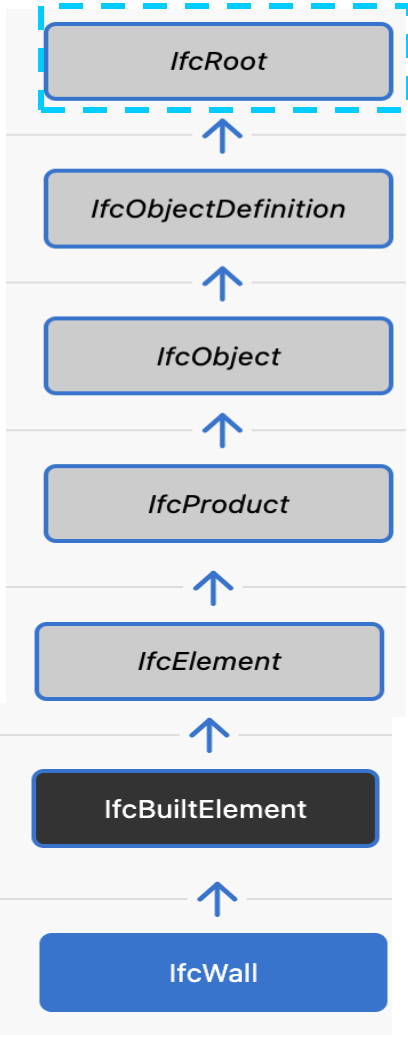
Table 5.1.3.44.C

5.1.3.44.6 Formal representation

```
ENTITY IfcRoot
 ABSTRACT SUPERTYPE OF (ONEOF
        (IfcObjectDefinition
        ,IfcPropertyDefinition
        ,IfcRelationship));
        GlobalId : IfcGloballyUniqueId;
        OwnerHistory : OPTIONAL IfcOwnerHistory;
        Name : OPTIONAL IfcLabel;
        Description : OPTIONAL IfcText;
 UNIQUE
        UR1 : GlobalId;
END_ENTITY;
```

5.1.3.44.7 References

- IfcBuildingElementProxy
- IfcObjectDefinition
- IfcProcedure
- IfcProject



IfxObjectDefinition

5.1.3.7 IfcObjectDefinition

ABSTRACT This definition may not be instantiated

5.1.3.7.1 Semantic definition

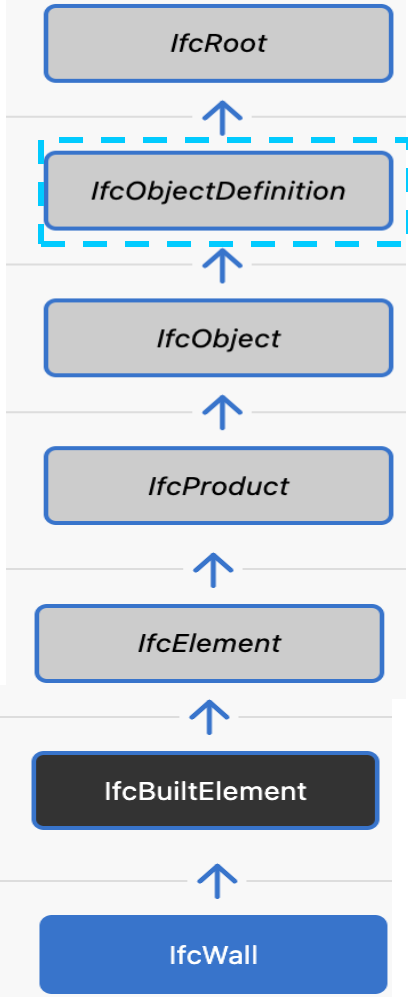
An *IfcObjectDefinition* is the generalization of any semantically treated thing or process, either being a type or an occurrence. Object definitions can be named, using the inherited *Name* attribute, which should be a user recognizable label for the object occurrence. Further explanations to the object can be given using the inherited *Description* attribute. A context is a specific kind of object definition as it provides the project or library context in which object types and object occurrences are defined.

Objects are independent pieces of information that might contain or reference other pieces of information. There are five essential kinds of relationships in which object definitions (by their instantiable subtypes) can be involved:

- **Assignment of other objects** - an assignment relationship (*IfcRelAssigns*) that refers to other types of objects and creates a bi-directional association. The semantic of the assignment is established at the level of the subtypes of the general *IfcRelAssigns* relationship. There is no dependency implied a priori by the assignment.
- **Association to external resources** - an association relationship (*IfcRelAssociates*) that refers to external sources of information (most notably a classification or document) and creates a uni-directional association. There is no dependency implied by the association.
- **Aggregation of other objects** - an aggregation relationship (*IfcRelAggregates*) that establishes an unordered, spatial whole/part relation and creates a bi-directional relation. There is an implied dependency established.
- **Nesting of other objects** - a nesting relationship (*IfcRelNests*) that establishes an ordered, non-spatial whole/part relation and creates a bi-directional relation. There is an implied dependency established.
- **Declaration within a context** - a relationship (*IfcRelDeclares*) of the uppermost object definition within the object definition tree (e.g. the summary object within an object nesting tree) to the context (a project or project library). It applies the units, representation context and other context information to this object definition and all dependent ones.

5.1.3.7.2 Entity inheritance

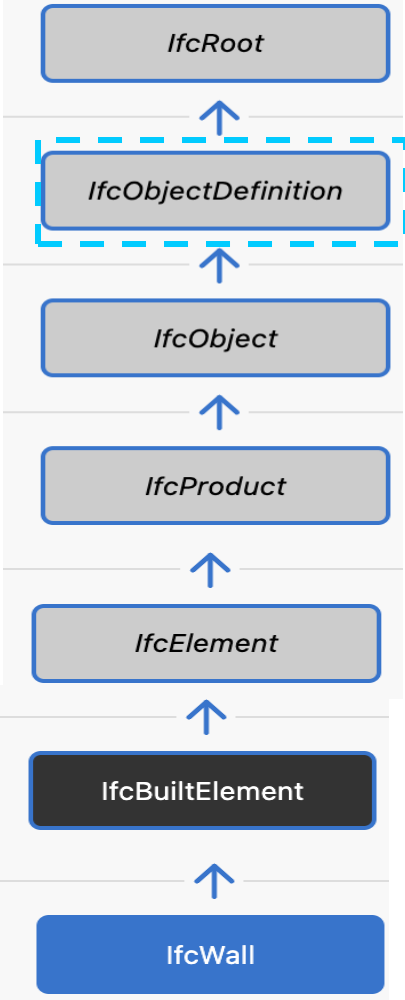




5.1.3.7.3 Attributes

#	Attribute	Type	Description
IfcRoot (4)			
	Click to show 4 hidden inherited attributes		
IfcObjectDefinition (7)			
	HasAssignments	SET [0:?] OF IfcRelAssigns FOR RelatedObjects	Reference to the relationship objects, that assign (by an association relationship) other subtypes of *IfcObject* to this object instance. Examples are the association to products, processes, controls, resources or groups.
	Nests	SET [0:1] OF IfcRelNests FOR RelatedObjects	References to the decomposition relationship being a nesting. It determines that this object definition is a part within an ordered whole/part decomposition relationship. An object occurrence or type can only be part of a single decomposition (to allow hierarchical structures only). IFC4-CHANGE The inverse attribute datatype has been added and separated from *Decomposes* defined at *IfcObjectDefinition*.
	IsNestedBy	SET [0:?] OF IfcRelNests FOR RelatingObject	References to the decomposition relationship being a nesting. It determines that this object definition is the whole within an ordered whole/part decomposition relationship. An object or object type can be nested by several other objects (occurrences or types). IFC4-CHANGE The inverse attribute datatype has been added and separated from *IsDecomposedBy* defined at *IfcObjectDefinition*.
	HasContext	SET [0:1] OF IfcRelDeclares FOR RelatedDefinitions	References to the context providing context information such as project unit or representation context. It should only be asserted for the uppermost non-spatial object. IFC4-CHANGE The inverse attribute datatype has been added.
	IsDecomposedBy	SET [0:?] OF IfcRelAggregates FOR RelatingObject	References to the decomposition relationship being an aggregation. It determines that this object definition is whole within an unordered whole/part decomposition relationship. An object definition can be aggregated by several other objects (occurrences or parts). IFC4-CHANGE The inverse attribute datatype has been changed from the supertype *IfcRelDecomposes* to subtype *IfcRelAggregates*.
	Decomposes	SET [0:1] OF IfcRelAggregates FOR RelatedObjects	References to the decomposition relationship being an aggregation. It determines that this object definition is a part within an unordered whole/part decomposition relationship. An object definition can only be part of a single decomposition (to allow hierarchical structures only). IFC4-CHANGE The inverse attribute datatype has been changed from the supertype *IfcRelDecomposes* to subtype *IfcRelAggregates*.
	HasAssociations	SET [0:?] OF IfcRelAssociates FOR RelatedObjects	Reference to the relationship objects, that associates external references or other resource definitions to the object. Examples are the association to library, documentation or classification.

They are not numbered. They will be implicit attributes in STEP (file.ifc). They will actually be assigned/defined by "relationships".



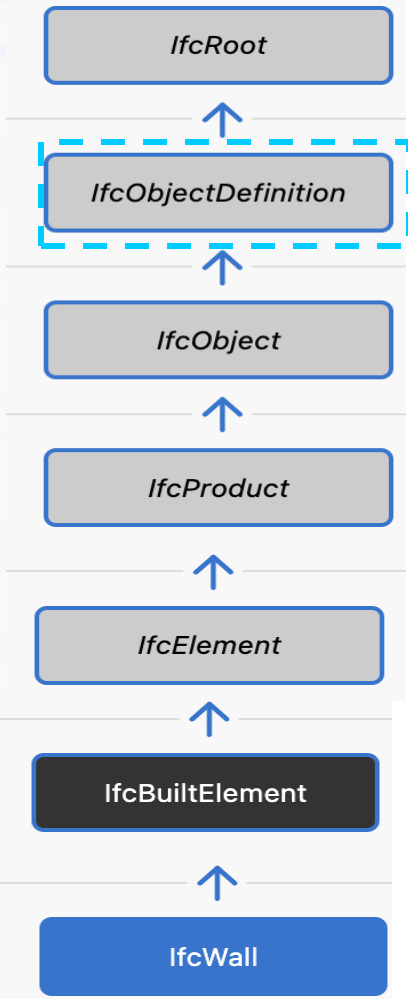
5.1.3.7.4 Concept usage

Concept	Usage	Description
IfcRoot (2)		
Click to show 2 hidden inherited concepts		
IfcObjectDefinition (9)		
Classification Association	General	Any object occurrence or object type can have a reference to a specific classification reference, i.e. to a particular facet within a classification system.
Aggregation	General	*No description available.*
Approval Association	General	*No description available.*
Constraint Association	General	*No description available.*
Document Association	General	*No description available.*
Library Association	General	*No description available.*
Material Association	General	*No description available.*
Material Single	General	*No description available.*
Nesting	General	*No description available.*

Table 5.1.3.7.B

5.1.3.7.5 Formal representation

```
ENTITY IfcObjectDefinition
 ABSTRACT SUPERTYPE OF (ONEOF
        (IfcContext
        ,IfcObject
        ,IfcTypeObject))
 SUBTYPE OF (IfcRoot);
 INVERSE
        HasAssignments : SET [0:?] OF IfcRelAssigns FOR RelatedObjects;
        Nests : SET [0:1] OF IfcRelNests FOR RelatedObjects;
        IsNestedBy : SET [0:?] OF IfcRelNests FOR RelatingObject;
        HasContext : SET [0:1] OF IfcRelDeclares FOR RelatedDefinitions;
        IsDecomposedBy : SET [0:?] OF IfcRelAggregates FOR RelatingObject;
        Decomposes : SET [0:1] OF IfcRelAggregates FOR RelatedObjects;
        HasAssociations : SET [0:?] OF IfcRelAssociates FOR RelatedObjects;
END_ENTITY;
```



5.1.3.6 IfcObject

ABSTRACT This definition may not be instantiated

5.1.3.6.1 Semantic definition

An *IfcObject* is the generalization of any semantically treated thing or process. Objects are things as they appear - i.e. occurrences.

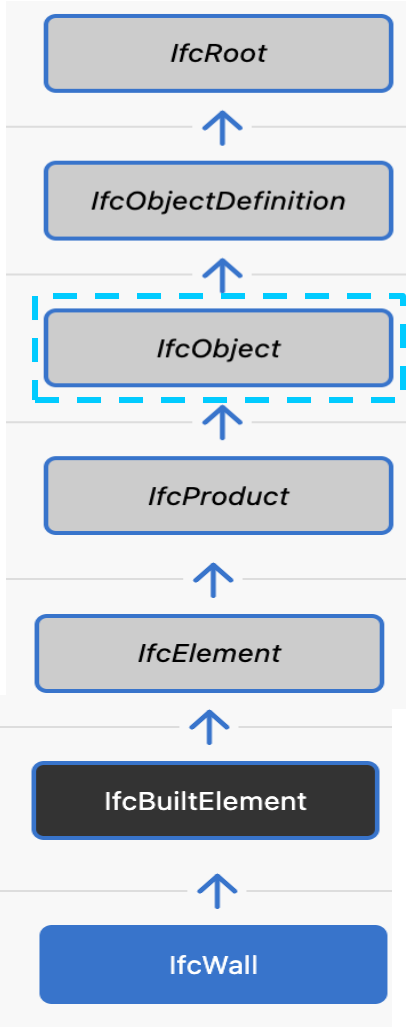
NOTE Examples of *IfcObject* include physically tangible items such as wall, beam or covering, physically existing items such as spaces, or conceptual items such as grids or virtual boundaries. It also stands for processes such as work tasks, for controls such as cost items, or for actors such as persons involved in the design process.

Objects can be named, using the inherited *Name* attribute, which should be a user recognizable label for the object occurrence. Further explanations to the object can be given using the inherited *Description* attribute. The *ObjectType* attribute is used:

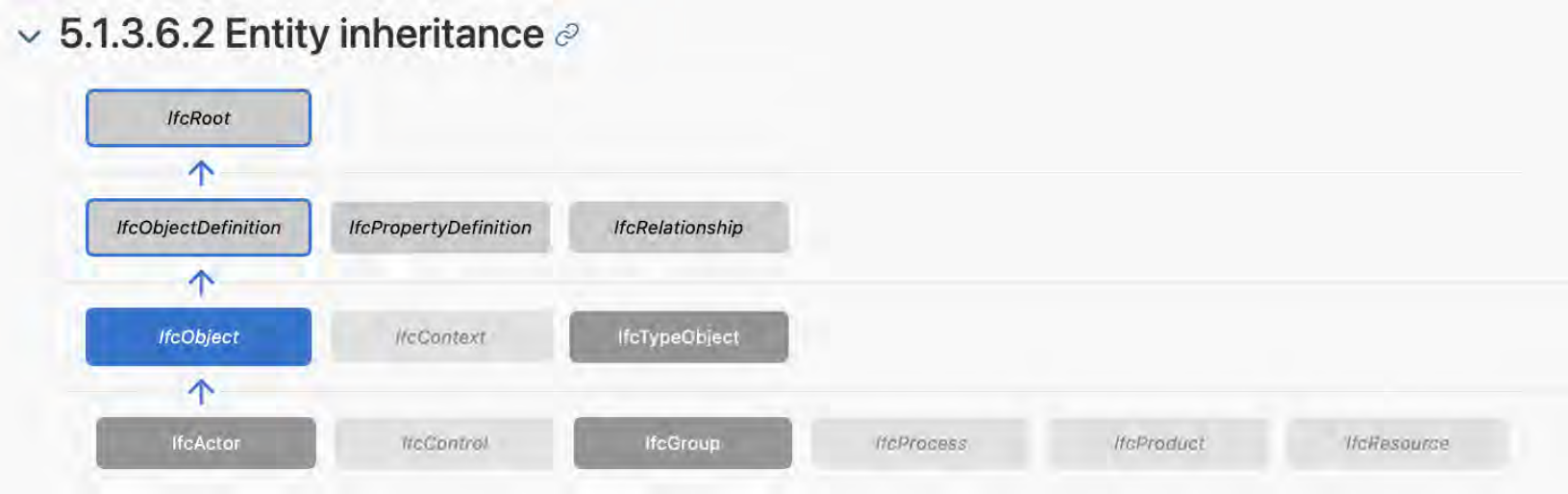
— to store the user defined value for all subtypes of *IfcObject*, where a *PredefinedType* attribute is given, and its value is set to USERDEFINED.
— to provide a type information (could be seen as a very lightweight classifier) of the subtype of *IfcObject*, if no *PredefinedType* attribute is given. This is often the case, if no comprehensive list of predefined types is available.

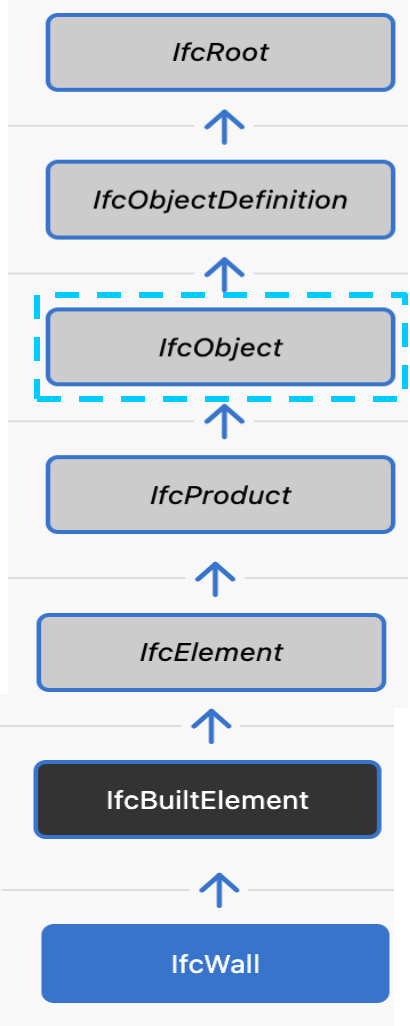
Objects are independent pieces of information that might contain or reference other pieces of information. There are several relationships in which objects can be involved:

— **Association to external/internal resource information** - an association relationship that refers to external/internal sources of information. See supertype *IfcObjectDefinition* for more information.
— **Assignment of other objects** - an assignment relationship that refers to other types of objects. See supertype *IfcObjectDefinition* for more information.
— **Aggregation of other objects** - an aggregation relationship that establishes a whole/part relation. Objects can either be a whole, or a part, or both. See supertype *IfcObjectDefinition* for more information.
— **Assignment of a type** : *IsTypedBy* - a definition relationship *IfcRelDefinesByType* that uses a type definition to define the common characteristics of this occurrence, potentially including the common shape representation and common properties of all object occurrences assigned to this type. It is a specific - occurrence relationship with implied dependencies (as the occurrence properties depend on the properties of the type, but may override them).
— **Assignment of a partial type** : *IsDeclaredBy*, *Declares* - a definition relationship *IfcRelDefinesByObject* that uses a component of a type definition (a part of a type, called the "declaring part") to define a component of an occurrence (part of occurrence, called the "reflected part"). This is also referred to as a "deep copy". The common characteristics of all parts in the occurrence are defined by parts in the type. It is a specific - occurrence relationship with implied dependencies (as the occurrence properties depend on the properties of the type, but may override them).
— **Assignment of property sets** : *IsDefinedBy* - a definition relationship *IfcRelDefinesByProperties* that assigns property set definitions to the object occurrence.



IfcObject


5.1.3.6.2 Entity inheritance
IfcRoot
IfcObjectDefinition
IfcPropertyDefinition
IfcRelationship
IfcObject
IfcContext
IfcTypeObject
IfcActor
IfcControl
IfcGroup
IfcProcess
IfcProduct
IfcResource

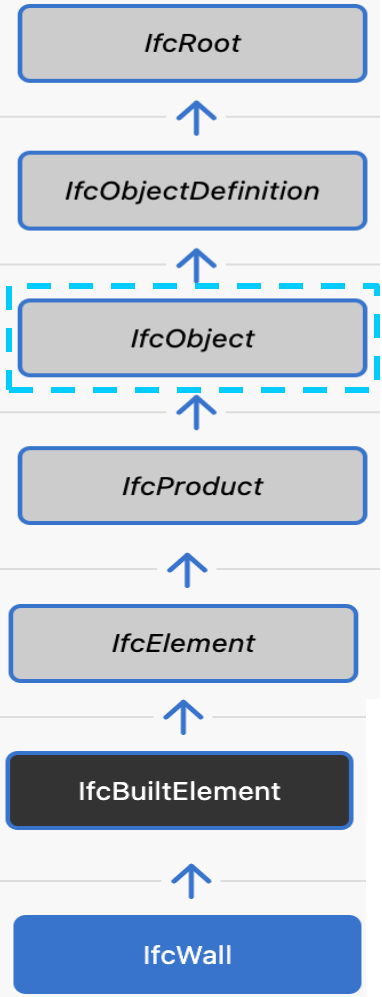

IfcRoot
IfcObjectDefinition
IfcObject
IfcProduct
IfcElement
IfcBuiltElement
IfcWall

5.1.3.6.3 Attributes

#	Attribute	Type	Description
IfcRoot (4)			
IfcObjectDefinition (7)			
Click to show 11 hidden inherited attributes			
IfcObject (5)			
5	ObjectType	OPTIONAL IfcLabel	The type denotes a particular type that indicates the object further. The use has to be established at the level of instantiable subtypes. In particular it holds the user defined type, if the enumeration of the attribute *PredefinedType* is set to USERDEFINED or when the concrete entity instantiated does not have a PredefinedType attribute. The latter is the case in some exceptional leaf classes and when instantiating IfcBuiltElement directly.
	IsDeclaredBy	SET [0:1] OF IfcRelDefinesByObject FOR RelatedObjects	Link to the relationship object pointing to the declaring object that provides the object definitions for this object occurrence. The declaring object has to be part of an object type decomposition. The associated *IfcObject*, or its subtypes, contains the specific information (as part of a type, or style, definition), that is common to all reflected instances of the declaring *IfcObject*, or its subtypes. IFC4-CHANGE New inverse relationship, change made with upward compatibility for file based exchange.
	Declares	SET [0:?] OF IfcRelDefinesByObject FOR RelatingObject	Link to the relationship object pointing to the reflected object(s) that receives the object definitions. The reflected object has to be part of an object occurrence decomposition. The associated *IfcObject*, or its subtypes, provides the specific information (as part of a type, or style, definition), that is common to all reflected instances of the declaring *IfcObject*, or its subtypes. IFC4-CHANGE New inverse relationship, change made with upward compatibility for file based exchange.
	IsTypedBy	SET [0:1] OF IfcRelDefinesByType FOR RelatedObjects	Set of relationships to the object type that provides the type definitions for this object occurrence. The then associated *IfcTypeObject*, or its subtypes, contains the specific information (or type, or style), that is common to all instances of *IfcObject*, or its subtypes, referring to the same type. IFC4-CHANGE New inverse relationship, the link to *IfcRelDefinesByType* was previously included in the inverse relationship *IfcRelDefines*. Change made with upward compatibility for file based exchange.
	IsDefinedBy	SET [0:?] OF IfcRelDefinesByProperties FOR RelatedObjects	Set of relationships to property set definitions attached to this object. Those statically or dynamically defined properties contain alphanumeric information content that further defines the object. IFC4-CHANGE The data type has been changed from *IfcRelDefines* to *IfcRelDefinesByProperties* with upward compatibility for file based exchange.

Table 5.1.3.6.A

Here we have one numbered attribute (5) and the rest "unnumbered", therefore "implicit".



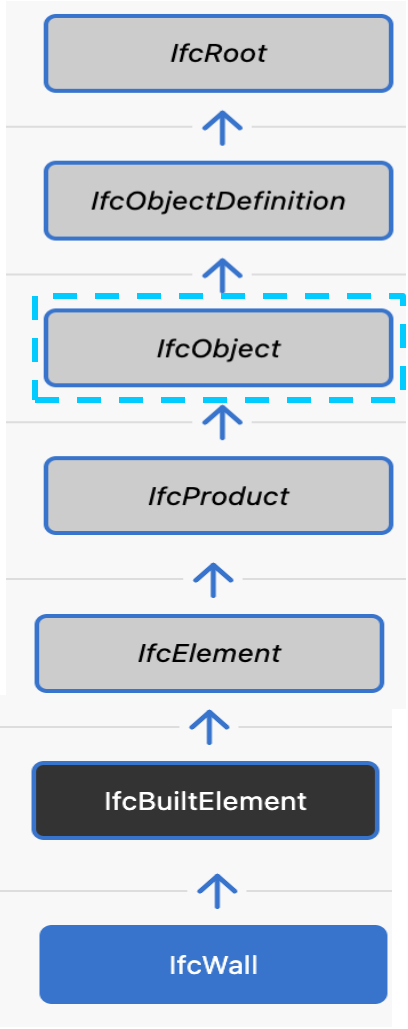
5.1.3.6.5 Concept usage

Concept	Usage	Description
IfcRoot (2)		
IfcObjectDefinition (9)		
Click to show 11 hidden inherited concepts		
IfcObject (5)		
Object Predefined Type	General	*No description available.*
Object Typing	General	Any object occurrence can be typed by being assigned to a common object type utilizing this concept. A particular rule, restricting the applicable subtypes of *IfcTypeObject* that can be assigned, is introduced by overriding this concept at the level of subtypes of *IfcObject*. This concept can be applied to the following resources: — IfcTypeObject
Object User Identity	General	An attribute *Name* and optionally *Description* can be used for all subypes of *IfcObject*. For those subtypes, that have an object type definition, such as *IfcBeam* - *IfcBeamType*, the common *Name* and optionally *Description* is associated with the object type.
Property Sets with Override	General	Any object occurrence can hold property sets, either directly at the object occurrence as element specific property sets, or at the object type, as type property sets. In this case, the properties that are provided to the object occurrence are the combinations of element specific and type properties. In case that the same property (within the same property set) is defined both in occurrence and type properties, the property value of the occurrence property overrides the property value of the type property.
Assignment to Group	General	*No description available.*

Table 5.1.3.6.C

5.1.3.6.6 Formal representation

```
ENTITY IfcObject
 ABSTRACT SUPERTYPE OF (ONEOF
        (IfcActor
        ,IfcControl
        ,IfcGroup
        ,IfcProcess
        ,IfcProduct
        ,IfcResource))
 SUBTYPE OF (IfcObjectDefinition);
        ObjectType : OPTIONAL IfcLabel;
 INVERSE
        IsDeclaredBy : SET [0:1] OF IfcRelDefinesByObject FOR RelatedObjects;
        Declares : SET [0:?] OF IfcRelDefinesByObject FOR RelatingObject;
        IsTypedBy : SET [0:1] OF IfcRelDefinesByType FOR RelatedObjects;
        IsDefinedBy : SET [0:?] OF IfcRelDefinesByProperties FOR RelatedObjects;
 WHERE
        UniquePropertySetNames : ((SIZEOF(IsDefinedBy) = 0) OR IfcUniqueDefinitionNames(IsDefinedBy));
END_ENTITY;
```



5.1.3.10 IfcProduct

ABSTRACT This definition may not be instantiated

5.1.3.10.1 Semantic definition

The *IfcProduct* is an abstract representation of any object that relates to a geometric or spatial context. An *IfcProduct* occurs at a specific location in space if it has a geometric representation assigned. It can be placed relatively to other products, but ultimately relative to the project coordinate system. The *ObjectPlacement* attribute establishes the coordinate system in which all points and directions used by the geometric representation items under *Representation* are founded. The *Representation* is provided by an *IfcProductDefinitionShape* being either a geometric shape representation, or a topology representation (with or without underlying geometry of the topological items).

Products include manufactured, supplied or created objects (referred to as elements) for incorporation into an AEC/FM project. This also includes objects that are created indirectly by other products, as spaces are defined by bounding elements. Products can be designated for permanent use or temporary use, an example for the latter is formwork. Products are defined by their properties and representations.

In addition to physical products (covered by the subtype *IfcElement*) and spatial items (covered by the subtype *IfcSpatialElement*) the *IfcProduct* also includes non-physical items, that relate to a geometric or spatial contexts, such as grid, port, annotation, structural actions, etc.

Any instance of *IfcProduct* defines a particular occurrence of a product. The common type information, that relates to many similar (or identical) occurrences of *IfcProduct*, is handled by the *IfcTypeProduct* (and its subtypes), assigned to one or many occurrences of *IfcProduct* by using the objectified relationship *IfcRelDefinesByType*. The *IfcTypeProduct* may provide, in addition to common properties, also a common geometric representation for all occurrences.

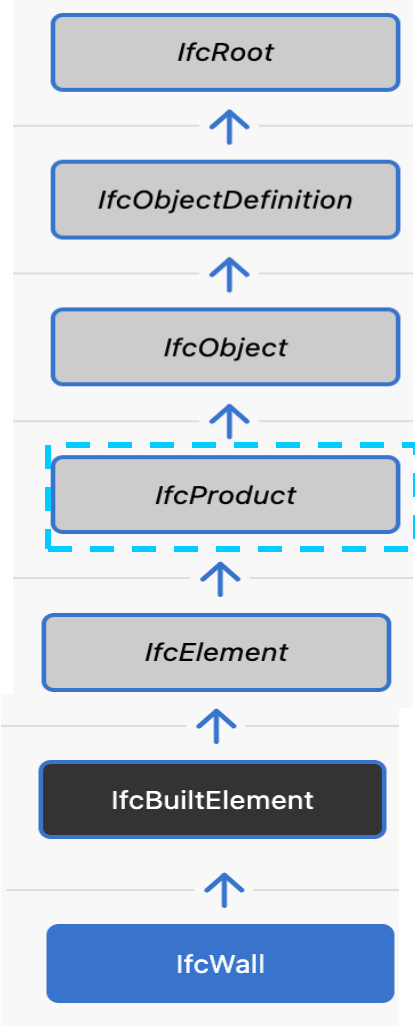
NOTE See *IfcTypeProduct* for how to use a common geometric representation and *IfcRelDefinesByType* for using and overriding common properties.

On a generic level products can be assigned to processes, controls, resources, project by using the relationship objects that refer to the corresponding object:

- **Having a control applied**: assigned using *IfcRelAssignsToControl* linking the *IfcProduct* to an *IfcControl*
- **Being assigned to a process**: assigned using *IfcRelAssignsToProcess* linking the *IfcProduct* to an *IfcProcess*
- **Being assigned to a resource**: assigned using *IfcRelAssignsToResource* linking the *IfcProduct* to an *IfcResource*

5.1.3.10.2 Entity inheritance





5.1.3.10.3 Attributes

#	Attribute	Type	Description
IfcRoot (4)			
IfcObjectDefinition (7)			
IfcObject (5)			
Click to show 16 hidden inherited attributes			
IfcProduct (5)			
6	ObjectPlacement	OPTIONAL IfcObjectPlacement	This establishes the object coordinate system and placement of the product in space. The placement can either be absolute (relative to the world coordinate system), relative (relative to the object placement of another product), or constrained (e.g. relative to grid axes, or to a linear positioning element). The type of placement is determined by the various subtypes of *IfcObjectPlacement*. An object placement must be provided if a representation is present.
7	Representation	OPTIONAL IfcProductRepresentation	Reference to the representations of the product, being either a representation (*IfcProductRepresentation*) or as a special case of a shape representation (*IfcProductDefinitionShape*). The product definition shape provides for multiple geometric representations of the shape property of the object within the same object coordinate system, defined by the object placement.
	ReferencedBy	SET [0:?] OF IfcRelAssignsToProduct FOR RelatingProduct	Reference to the *IfcRelAssignsToProduct* relationship, by which other products, processes, controls, resources or actors (as subtypes of *IfcObjectDefinition*) can be related to this product.
	PositionedRelativeTo	SET [0:?] OF IfcRelPositions FOR RelatedProducts	Reference to the *IfcRelPositions* relationship, which defines its relationship with a positioning element.
	ReferencedInStructures	SET [0:?] OF IfcRelReferencedInSpatialStructure FOR RelatedElements	Reference to the objectified relationship *IfcRelReferencedInSpatialStructure* may be used to relate a product to one or more spatial structure elements in addition to the one in which it is primarily contained.

Table 5.1.3.10.A

Here we have two numbered attributes (6,7) and the rest "unnumbered", therefore "implicit".

5.1.3.10.4 Formal propositions

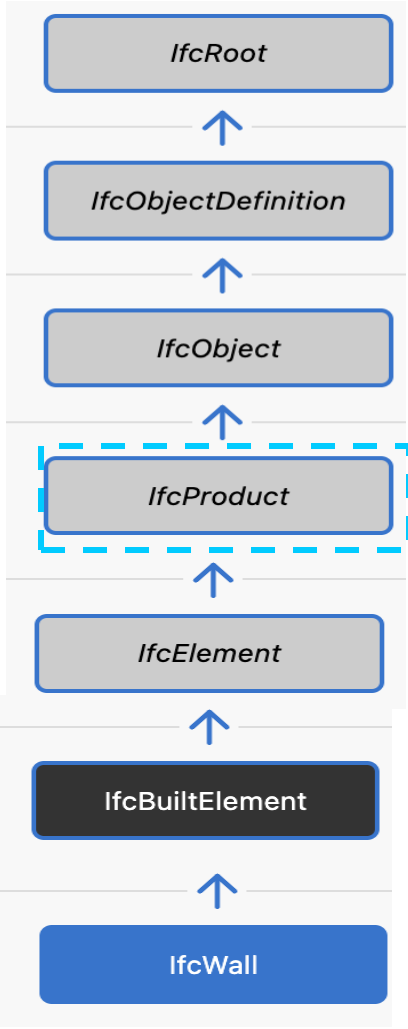
5.1.3.10.5 Property sets

Pset_Risk
RiskName
RiskType

Pset_Tolerance
ToleranceDescription
ToleranceBasis

Pset_Uncertainty
UncertaintyBasis
UncertaintyDescription

Qto_BodyGeometryValidation
GrossSurfaceArea
NetSurfaceArea

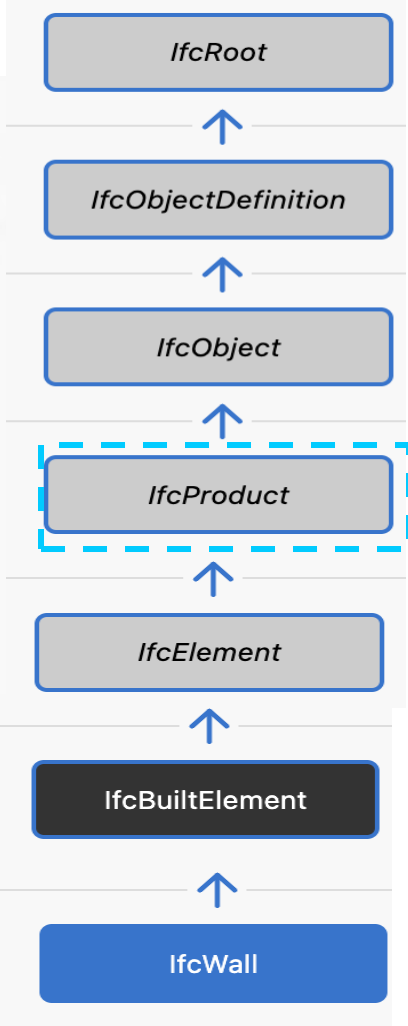


IfcProduct

5.1.3.10.6 Concept usage

5.1.3.10.7 Formal representation

```
ENTITY IfcProduct
 ABSTRACT SUPERTYPE OF (ONEOF
        (IfcAnnotation
        ,IfcElement
        ,IfcLinearElement
        ,IfcPort
        ,IfcPositioningElement
        ,IfcSpatialElement
        ,IfcStructuralActivity
        ,IfcStructuralItem))
 SUBTYPE OF (IfcObject);
        ObjectPlacement : OPTIONAL IfcObjectPlacement;
        Representation : OPTIONAL IfcProductRepresentation;
 INVERSE
        ReferencedBy : SET [0:?] OF IfcRelAssignsToProduct FOR RelatingProduct;
        PositionedRelativeTo : SET [0:?] OF IfcRelPositions FOR RelatedProducts;
        ReferencedInStructures : SET [0:?] OF IfcRelReferencedInSpatialStructure FOR RelatedElements;
 WHERE
        PlacementForShapeRepresentation : (EXISTS(Representation) AND EXISTS(ObjectPlacement))
            OR (EXISTS(Representation) AND
       (SIZEOF(QUERY(temp <* Representation.Representations | 'IFC4X3_ADD2.IFCSHAPEREPRESENTATION' IN TYPEOF(temp))) = 0))
            OR (NOT(EXISTS(Representation)));
END_ENTITY;
```



5.4.3.18 IfcElement

NOTE This entity is a subtype of IfcProduct or IfcTypeProduct and hence part of every standardized schema subset and implementation level.

ABSTRACT This definition may not be instantiated

5.4.3.18.1 Semantic definition

An element is a generalization of all components that make up a facility.

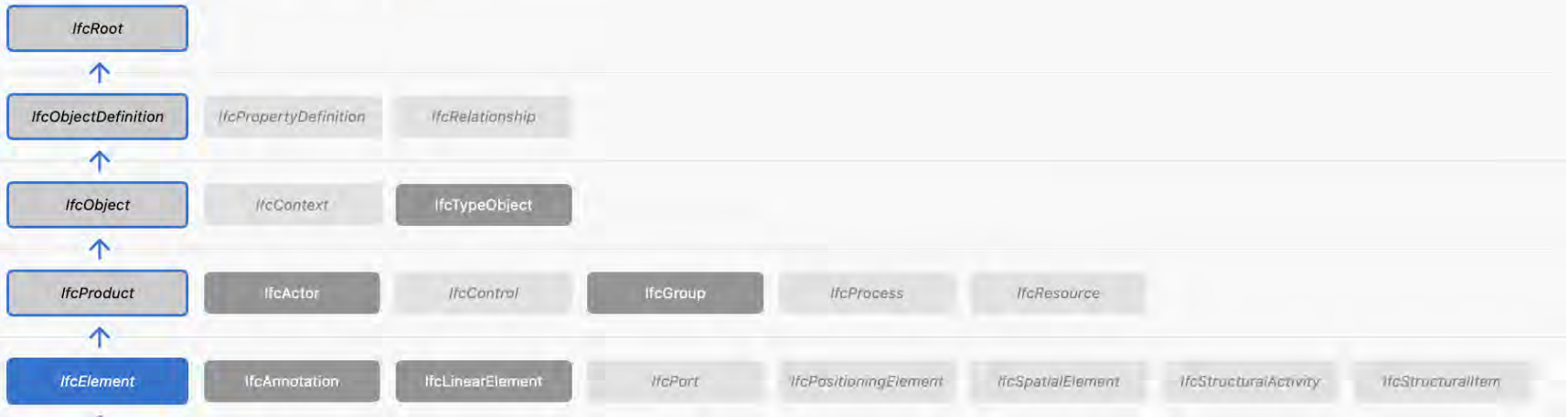
Elements are physically existent objects, although they might be void elements, such as holes. Elements either remain permanently in the facility, or only temporarily, as formwork does. Elements can be either assembled on site or pre-manufactured and built in on site.

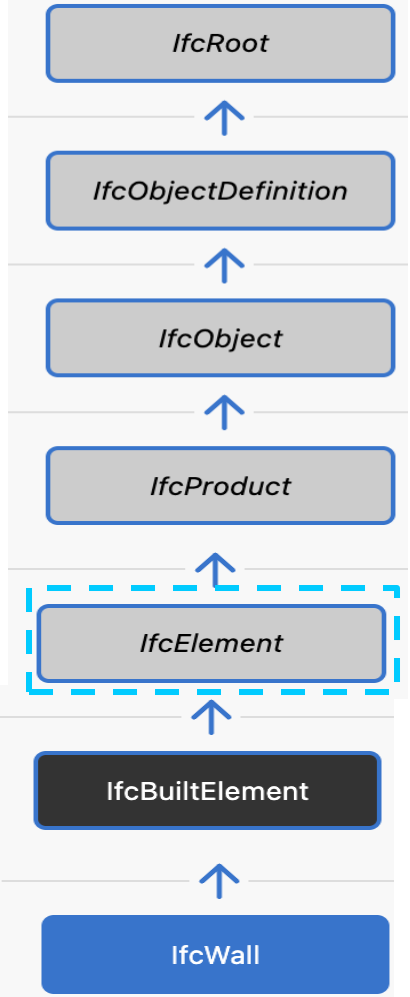
EXAMPLE Examples of elements in a building construction context are walls, floors, windows and recesses.

The elements can be logically contained by a spatial structure element that constitutes a certain level within a project structure hierarchy (site, building, storey or space). This is done by using the *IfcRelContainedInSpatialStructure* relationship. An element can have material and quantity information assigned through the *IfcRelAssociatesMaterial* and *IfcRelDefinesByProperties* relationship.

In addition an element can be declared to be a specific occurrence of an element type (and thereby be defined by the element type properties) using the *IfcRelDefinesByType* relationship. An element can also be defined as an element assembly that is a group of semantically and topologically related elements that form a higher level part of the facility. Those element assemblies are defined by virtue of the *IfcRelAggregates* relationship.

5.4.3.18.2 Entity inheritance

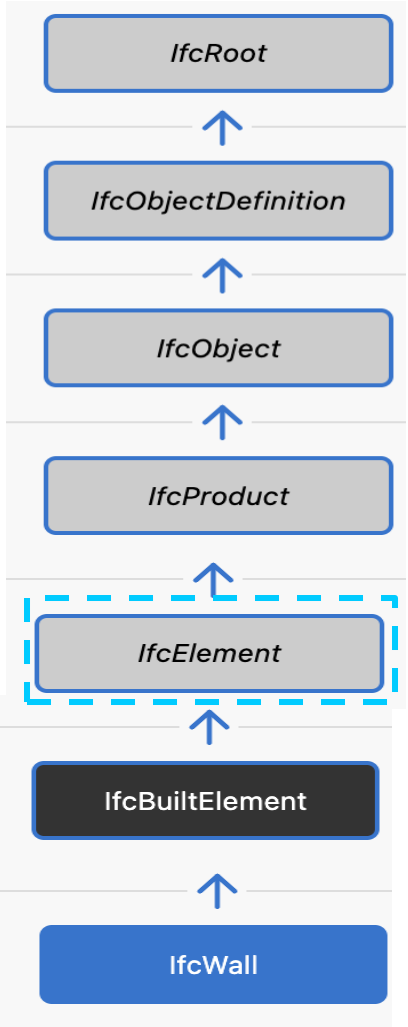




Here we have one numbered attribute (8) and the rest "unnumbered", therefore "implicit".

#	Attribute	Type	Description
			Click to show 21 hidden inherited attributes
	IfcElement (13)		
8	Tag	OPTIONAL IfcIdentifier	The tag (or label) identifier at the particular instance of a product, e.g. the serial number, or the position number. It is the identifier at the occurrence level.
	FillsVoids	SET [0:1] OF IfcRelFillsElement FOR RelatedBuildingElement	Reference to the *IfcRelFillsElement* relationship that puts the element as a filling into the opening created within another element.
	ConnectedTo	SET [0:?] OF IfcRelConnectsElements FOR RelatingElement	Reference to the element connection relationship. The relationship then refers to the other element to which this element is connected to.
	IsInterferedByElements	SET [0:?] OF IfcRelInterferesElements FOR RelatedElement	Reference to the interference relationship to indicate the element that is interfered. The relationship, if provided, indicates that this element has an interference with one or many other elements. NOTE There is no indication of precedence between *IsInterferedByElements* and *InterferesElements*. IFC4-CHANGE New inverse relationship.
	InterferesElements	SET [0:?] OF IfcRelInterferesElements FOR RelatingElement	Reference to the interference relationship to indicate the element that interferes. The relationship, if provided, indicates that this element has an interference with one or many other elements. NOTE There is no indication of precedence between *IsInterferedByElements* and *InterferesElements*. IFC4-CHANGE New inverse relationship.
	HasProjections	SET [0:?] OF IfcRelProjectsElement FOR RelatingElement	Projection relationship that adds a feature (using a Boolean union) to the *IfcBuiltElement*.
	HasOpenings	SET [0:?] OF IfcRelVoidsElement FOR RelatingBuildingElement	Reference to the *IfcRelVoidsElement* relationship that creates an opening in an element. An element can incorporate zero-to-many openings. For each opening, that voids the element, a new relationship *IfcRelVoidsElement* is generated.
	IsConnectionRealization	SET [0:?] OF IfcRelConnectsWithRealizingElements FOR RealizingElements	Reference to the connection relationship with realizing element. The relationship, if provided, assigns this element as the realizing element to the connection, which provides the physical manifestation of the connection relationship.
	ProvidesBoundaries	SET [0:?] OF IfcRelSpaceBoundary FOR RelatedBuildingElement	Reference to space boundaries by virtue of the objectified relationship *IfcRelSpaceBoundary*. It defines the concept of an element bounding spaces.
	ConnectedFrom	SET [0:?] OF IfcRelConnectsElements FOR RelatedElement	Reference to the element connection relationship. The relationship then refers to the other element that is connected to this element.
	ContainedInStructure	SET [0:1] OF IfcRelContainedInSpatialStructure	Containment relationship to the spatial structure element, to which the element is

(…)



IfcElement

5.4.3.18.4 Property sets

Pset_Condition
AssessmentDate
AssessmentCondition
AssessmentDescription

Pset_ConstructionAdministration
ProcurementMethod
SpecificationSectionNumber
SubmittalIdentifier

Pset_ConstructionOccurence
InstallationDate
ModelNumber
TagNumber

Pset_ElementKinematics
CyclicPath
CyclicRange
LinearPath

Pset_EnvironmentalCondition
ReferenceAirRelativeHumidity
ReferenceEnvironmentTemperature
MaximumAtmosphericPressure

Pset_EnvironmentalImpactIndicators
Reference
FunctionalUnitReference
IndicatorsUnit

Pset_EnvironmentalImpactValues
TotalPrimaryEnergyConsumption
WaterConsumption
HazardousWaste

Pset_InstallationOccurrence
InstallationDate
AcceptanceDate
PutIntoOperationDate

Pset_MaintenanceStrategy
AssetCriticality
AssetFrailty
AssetPriority

Pset_MaintenanceTriggerCondition
ConditionTargetPerformance
ConditionMaintenanceLevel
ConditionReplacementLevel

Pset_MaintenanceTriggerDuration
DurationTargetPerformance
DurationMaintenanceLevel
DurationReplacementLevel

Pset_MaintenanceTriggerPerformance
TargetPerformance
PerformanceMaintenanceLevel
ReplacementLevel

Pset_ManufacturerOccurrence
AcquisitionDate
BarCode
SerialNumber

Pset_ManufacturerTypeInformation
GlobalTradeItemNumber
ArticleNumber
ModelReference

Pset_RepairOccurrence
RepairContent
RepairDate
MeanTimeToRepair

Pset_Risk
RiskName
RiskType
NatureOfRisk

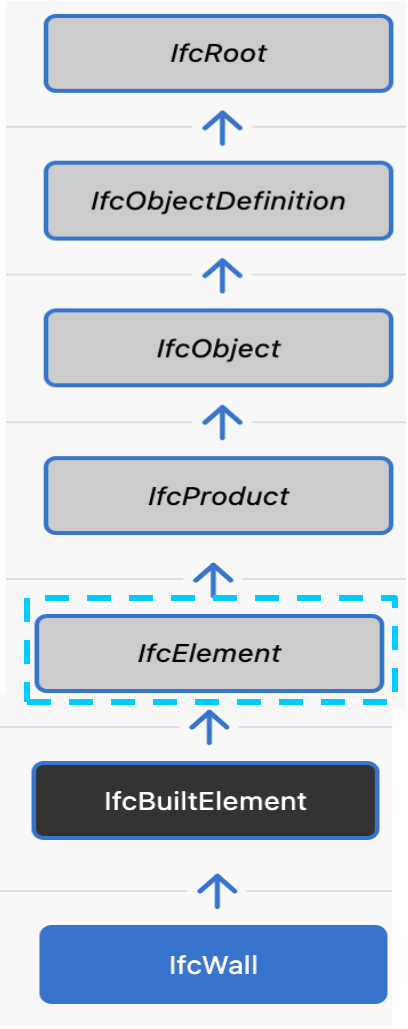
Pset_ServiceLife
ServiceLifeDuration
MeanTimeBetweenFailure

Pset_Tolerance
ToleranceDescription
ToleranceBasis
OverallTolerance

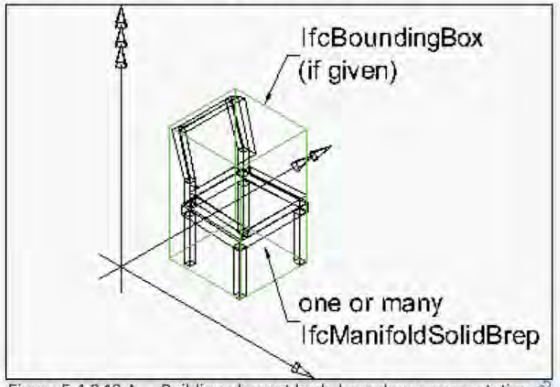
Pset_Uncertainty
UncertaintyBasis
UncertaintyDescription
HorizontalUncertainty

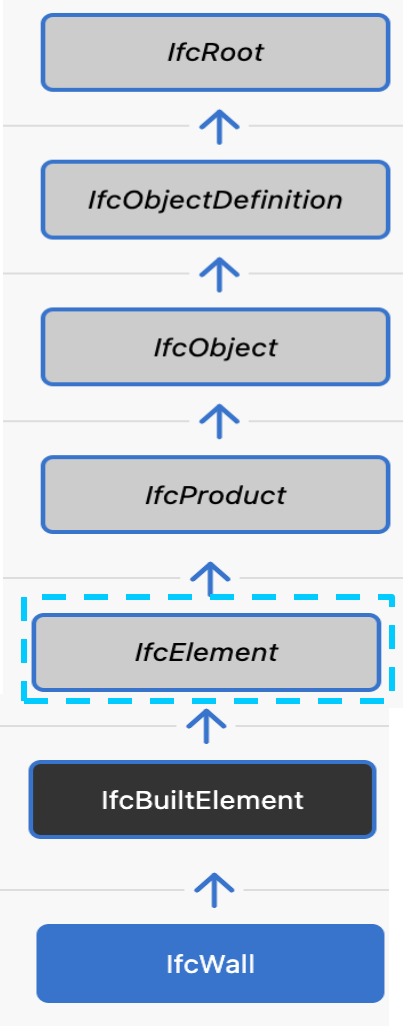
Pset_Warranty
WarrantyIdentifier
WarrantyStartDate
IsExtendedWarranty

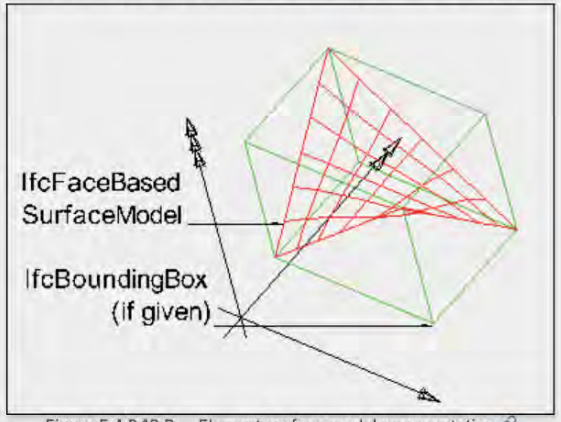
Qto_BodyGeometryValidation
GrossSurfaceArea
NetSurfaceArea
GrossVolume

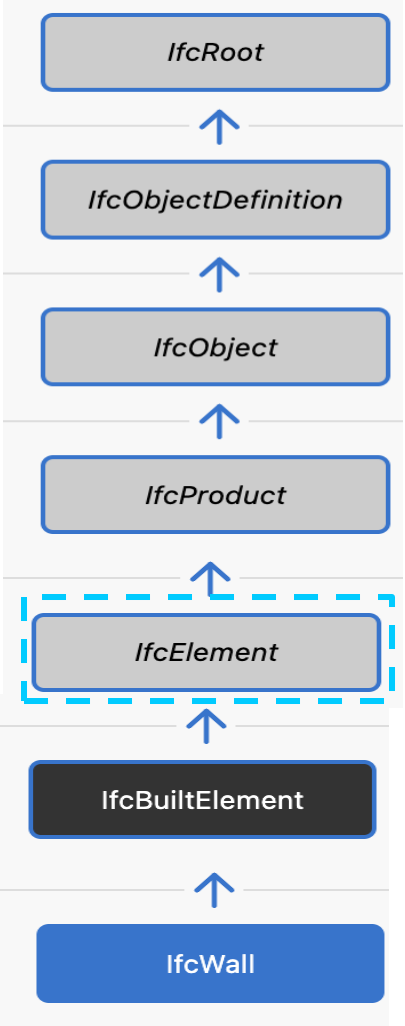


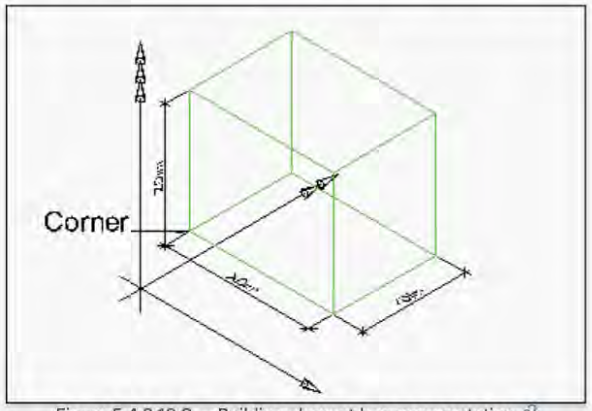
5.4.3.18.5 Concept usage

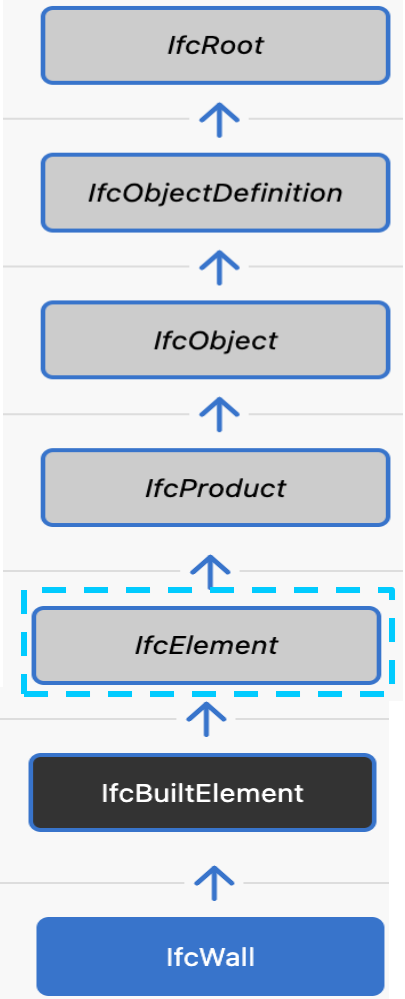
Concept	Usage	Description
IfcRoot (2)		
IfcObjectDefinition (9)		
IfcObject (5)		
IfcProduct (18)		
Click to show 34 hidden inherited concepts		
IfcElement (44)		
Body AdvancedBrep Geometry	General	An *IfcElement* (so far no further constraints are defined at the level of its subtypes or by view definitions) may be represented as a single or multiple boundary representation models, which include advanced surfaces, usually refered to as NURBS surfaces. The 'AdvancedBrep' representation allows for the representation of complex free-form element shape. NOTE View definitions or implementer agreements may restrict or disallow the use of 'AdvancedBrep' geometry.
Body AdvancedSwept Directrix Geometry	General	*No description available.*
Body AdvancedSwept DiskSolid PolyCurve Geometry	General	*No description available.*
Body AdvancedSwept Tapered Geometry	General	*No description available.*
Body Brep Geometry	General	Any *IfcElement* (so far no further constraints are defined at the level of its subtypes) may be represented as a single or multiple Boundary Representation models (which are restricted to be faceted Brep's with or without voids). The Brep representation allows for the representation of complex element shape.  Figure 5.4.3.18.A — Building element body boundary representation EXAMPLE As shown in Figure 5.4.3.18.A, the Brep representation is given by an *IfcShapeRepresentation*, which includes one or more items, all of type *IfcFacetedBrep*. In some cases it may be useful to also expose a simple representation as a bounding box representation of the same complex shape.



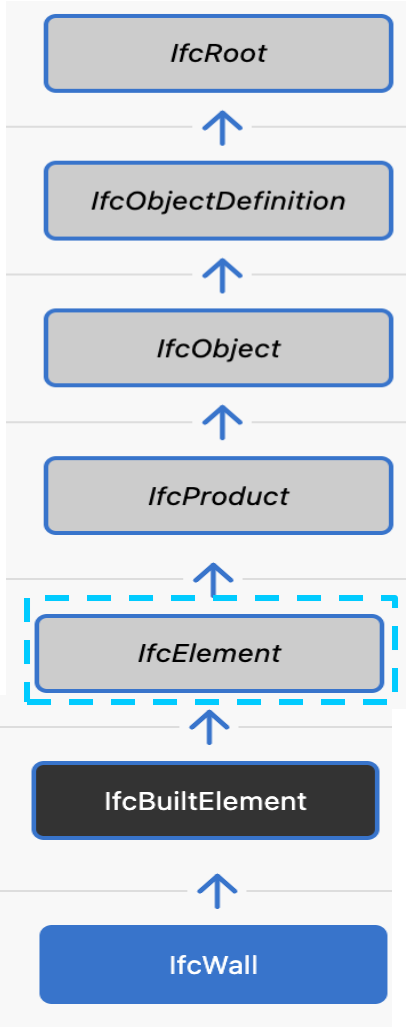
Concept	Usage	Description
Body CSG Geometry	General	Any *IfcElement* (so far no further constraints are defined at the level of its subtypes) may be represented as a CSG primitive or CSG tree. The CSG representation allows for the representation of complex element shape. NOTE View definitions or implementer agreements may restrict or disallow the use of 'CSG' geometry.
Body SectionedSolidHorizontal	General	*No description available.*
Body SurfaceModel Geometry	General	Any *IfcElement* (so far no further constraints are defined at the level of its subtypes) may be represented as a single or multiple surface models, based on either shell or face based surface models. It may also include tessellated models.  Figure 5.4.3.18.B — Element surface model representation EXAMPLE As shown in Figure 5.4.3.18.B, the surface model representation is given by an *IfcShapeRepresentation*, which includes a single item which is either an *IfcShellBasedSurfaceModel*, or an *IfcFaceBasedSurfaceModel*. In some cases it may also be useful to expose a simple representation as a bounding box representation of the same complex shape.
Body SurfaceOrSolidModel Geometry	General	Any *IfcElement* (so far no further constraints are defined at the level of its subtypes) may be represented as a mixed representation, including surface and solid models.
Body SweptSolid Composite Geometry	General	*No description available.*
Body SweptSolid CompositeCurve Geometry	General	*No description available.*
Body SweptSolid ParameterizedProfile Geometry	General	*No description available.*
Body SweptSolid PolyCurve Geometry	General	*No description available.*
Body Tessellation Geometry	Reference View	Any *IfcElement* (so far no further constraints are defined at the level of its subtypes) may be represented as a single or multiple tessellated surface models, in particular triangulated surface models.



Concept	Usage	Description
Box Geometry	General	This is a further elaboration on an inherited concept.  Figure 5.4.3.18.C — Building element box representation EXAMPLE Any *IfcElement* may be represented by a bounding box, which shows the maximum extent of the body within the object coordinate system established by the *IfcObjectPlacement*. As shown in Figure 5.4.3.18.C, the bounding box representation is given by an *IfcShapeRepresentation* that includes a single item: an *IfcBoundingBox*.
CoG Geometry	General	This is a further elaboration on an inherited concept. The 'CoG', Center of Gravity, shape representation is used as a means to verify the correct import by comparing the CoG of the imported geometry with the explicily provided CoG created during export.
Element Interference	General	*No description available.*
Element Nesting	General	A host element can nest connected components. This should be used when there is a specific position or form factor to attach specific elements. EXAMPLE A sink has a pre-drilled hole to attach a faucet.
Element Projecting	General	*No description available.*
Element Voiding Features	General	*No description available.*
FootPrint Annotation Geometry	General	*No description available.*
FootPrint GeomSet PolyCurve Geometry	General	*No description available.*
FootPrint Geometry	General	*No description available.*



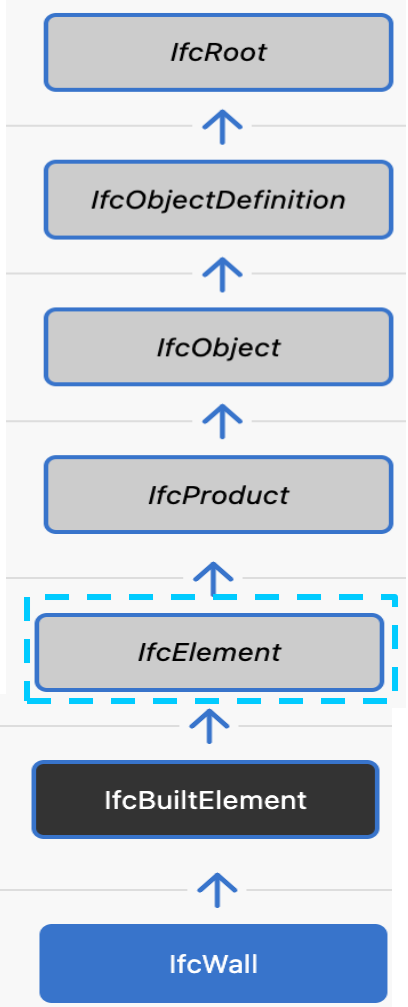
Concept	Usage	Description
Mapped Geometry	General	This is a further elaboration on an inherited concept. Any *IfcElement* (so far no further constraints are defined at the level of its subtypes) may be represented using the 'MappedRepresentation'. This shall be supported as it allows for reusing the geometry definition of a type at all occurrences of the same type. The results are more compact data sets. The same constraints, as given for 'SurfaceOrSolidModel', 'SurfaceModel', 'Tessellation', 'Brep', and 'AdvancedBrep' geometric representation, shall apply to the *IfcRepresentationMap*.
Product Grid Placement	General	*No description available.*
Product Linear Placement	General	Product placement with a *Product Linear Placement* template. It defines the local coordinate system based on the curve which is referenced by *IfcLinearPlacement.RelativePlacement* which is an *IfcAxis2PlacementLinear.Location* using an *IfcPointByDistanceExpression.BasisCurve*. The local coordinate system is based on the tangent of the curve at Location, its normal in the global Z plane and the cross product of the aforementioned vectors.
Product Local Placement	General	This is a further elaboration on an inherited concept. The object placement for any subtype of IfcElement is defined by the *IfcObjectPlacement*, either *IfcLocalPlacement* or *IfcGridPlacement*, which defines the local object coordinate system that is referenced by all geometric representations of that *IfcElement*.
Property Sets for Objects	General	This concept can be applied to the following resources: — Pset_Condition — Pset_InstallationOccurrence — Pset_MaintenanceStrategy — Pset_MaintenanceTriggerCondition — Pset_MaintenanceTriggerDuration — Pset_MaintenanceTriggerPerformance — Pset_RepairOccurrence — Pset_ConstructionAdministration — Pset_ConstructionOccurence — Pset_ElementKinematics — Pset_EnvironmentalCondition — Pset_EnvironmentalImpactIndicators — Pset_EnvironmentalImpactValues — Pset_ManufacturerOccurrence — Pset_ManufacturerTypeInformation — Pset_ServiceLife — Pset_Warranty
Surface Feature Adherence	General	*No description available.*
Surface Sectioned Geometry	General	*No description available.*
Surface Tessellation Geometry	General	*No description available.*
Body AdvancedSweptSolid Geometry	General	*No description available.*



IfcElement

Concept	Usage	Description
Body Clipping Geometry	General	*No description available.*
Body SweptSolid Geometry	General	*No description available.*
Element Covering	General	*No description available.*
Element Occurrence Attributes	General	*No description available.*
Element Voiding	General	*No description available.*
Lighting Geometry	General	*No description available.*
Object Typing	General	This concept can be applied to the following resources: — IfcElementType
Profile 3D Geometry	General	*No description available.*
Profile Geometry	General	*No description available.*
Spatial Containment	General	This concept can be applied to the following resources: — IfcSpatialElement
Surface 3D Geometry	General	*No description available.*
Surface Geometry	General	*No description available.*

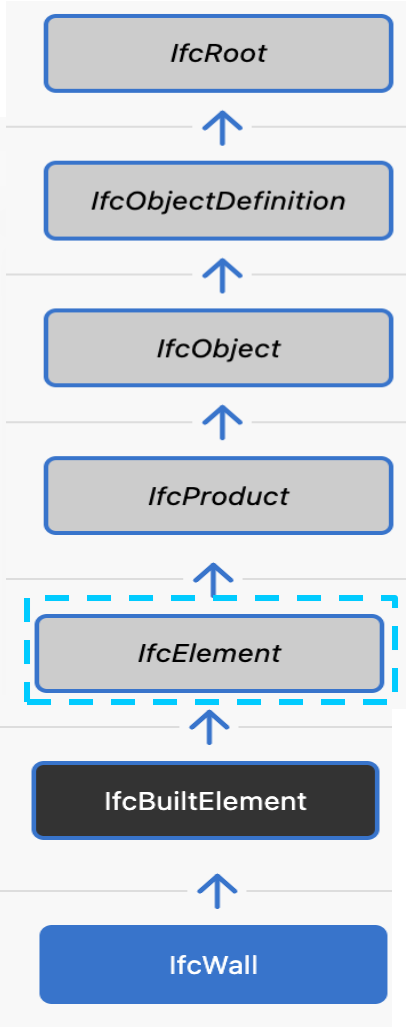
Table 5.4.3.18.E



IfcElement

5.4.3.18.6 Formal representation

```
ENTITY IfcElement
 ABSTRACT SUPERTYPE OF (ONEOF
        (IfcBuiltElement
        ,IfcCivilElement
        ,IfcDistributionElement
        ,IfcElementAssembly
        ,IfcElementComponent
        ,IfcFeatureElement
        ,IfcFurnishingElement
        ,IfcGeographicElement
        ,IfcGeotechnicalElement
        ,IfcTransportationDevice
        ,IfcVirtualElement))
 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;
        HasOpenings : SET [0:?] OF IfcRelVoidsElement FOR RelatingBuildingElement;
        IsConnectionRealization : SET [0:?] OF IfcRelConnectsWithRealizingElements FOR RealizingElements;
        ProvidesBoundaries : SET [0:?] OF IfcRelSpaceBoundary FOR RelatedBuildingElement;
        ConnectedFrom : SET [0:?] OF IfcRelConnectsElements FOR RelatedElement;
        ContainedInStructure : SET [0:1] OF IfcRelContainedInSpatialStructure FOR RelatedElements;
        HasCoverings : SET [0:?] OF IfcRelCoversBldgElements FOR RelatingBuildingElement;
        HasSurfaceFeatures : SET [0:?] OF IfcRelAdheresToElement FOR RelatingElement;
END_ENTITY;
```



5.4.3.11 IfcBuiltElement

NOTE This entity is a subtype of IfcProduct or IfcTypeProduct and hence part of every standardized schema subset and implementation level.

5.4.3.11.1 Semantic definition

The built element comprises all elements that are primarily part of the construction of a built facility, i.e., its structural and space separating system. Built elements are all physical existent and tangible things.

This *IfcBuiltElement* is a generalization of all elements that are major functional parts of the structural or space separation system of a built facility. Typical examples of *IfcBuiltElement* entities are (among others):

— built elements within a space separation system
— built elements within an enclosure system (such as a facade)
— built elements within a fenestration system
— built elements within a load bearing system
— built elements within a foundation system
— built elements within an infrastructure facility

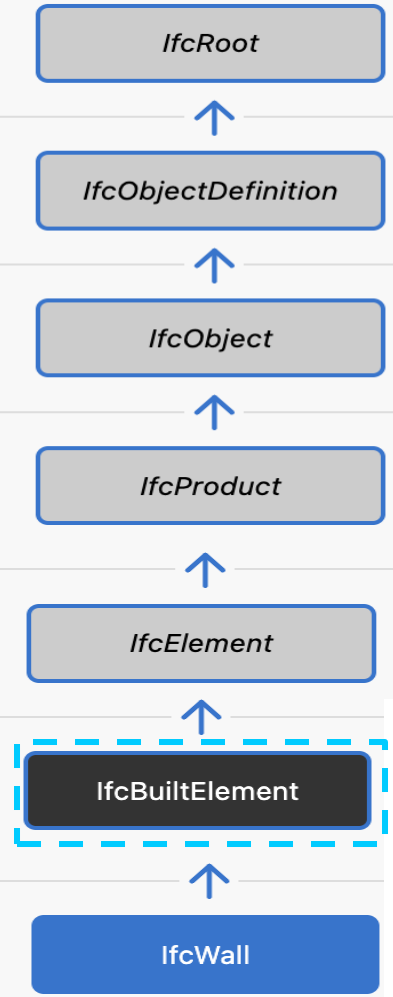
EXAMPLE built elements are curtain wall, doors, and others in case of buildings; walls, columns, pile, beams in case of buildings or infrastructure works; bearings in case of bridges; pavements in case of roads or rails in case of railways.

The *IfcBuiltElement* can be instantiated in the case when arbitrary built elements cannot be expressed by a subtype of *IfcBuiltElement*.

HISTORY New entity in IFC1.0

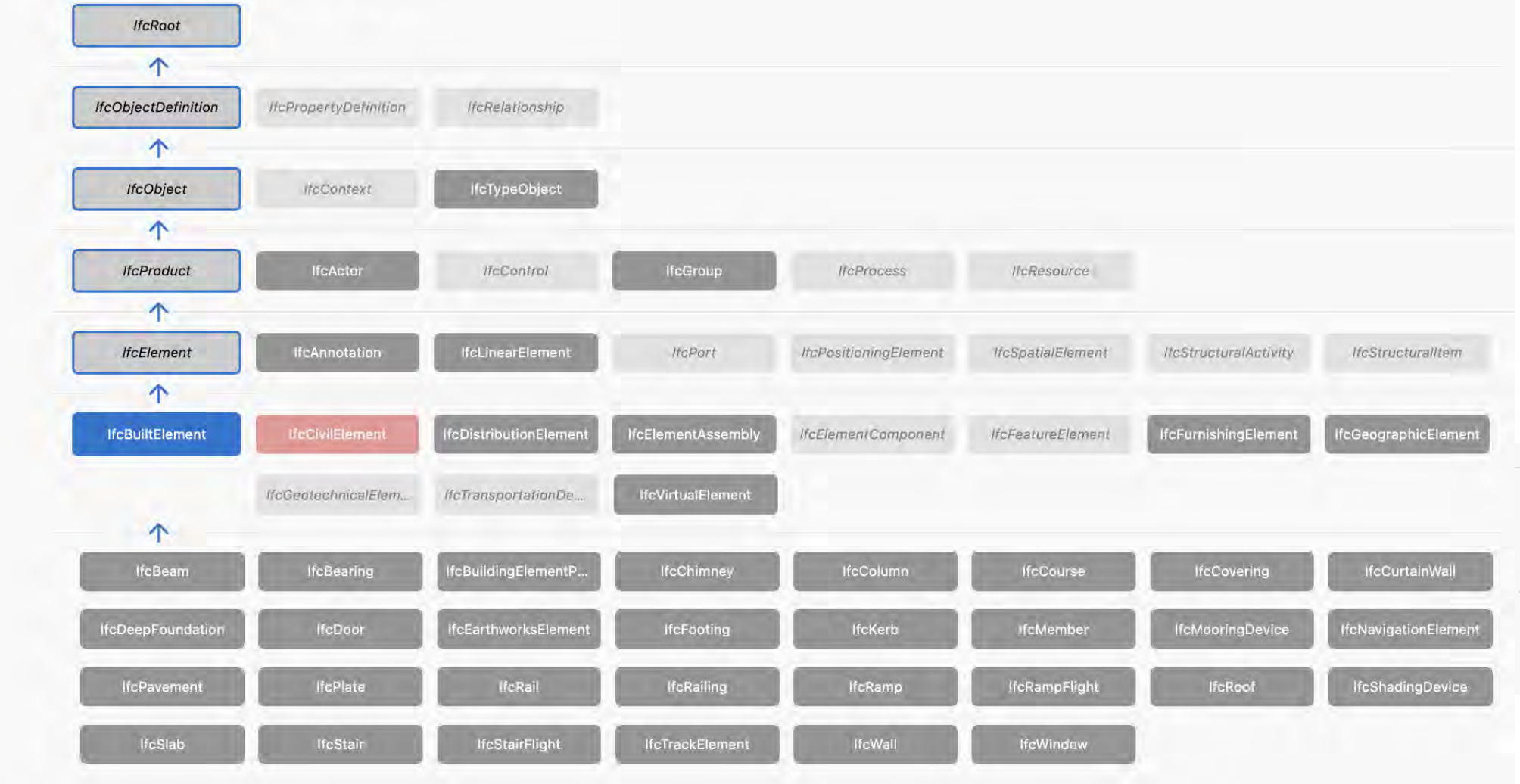
IFC4.3.0.0-CHANGE The entity has been renamed from IfcBuildingElement and made non abstract.

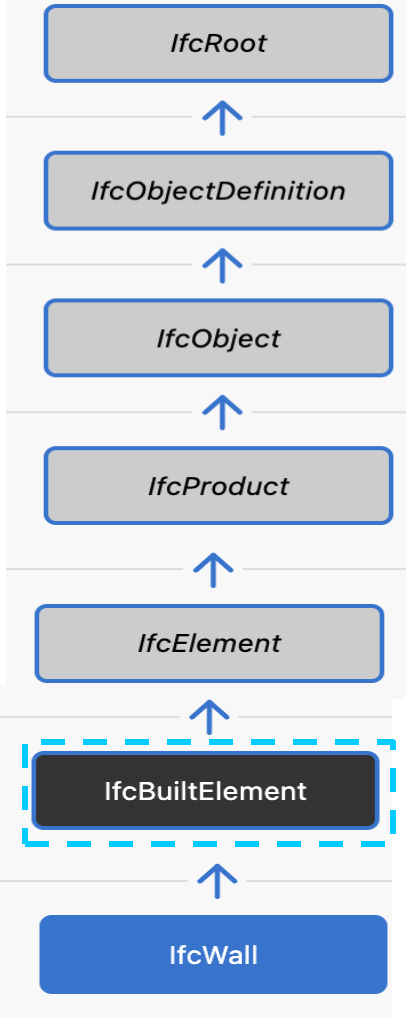
NOTE It is advised not to use *IfcBuildingElementProxy* to represent an arbitrary built element, but to use a direct instantiation of *IfcBuiltElement* instead.



IfcBuiltElement

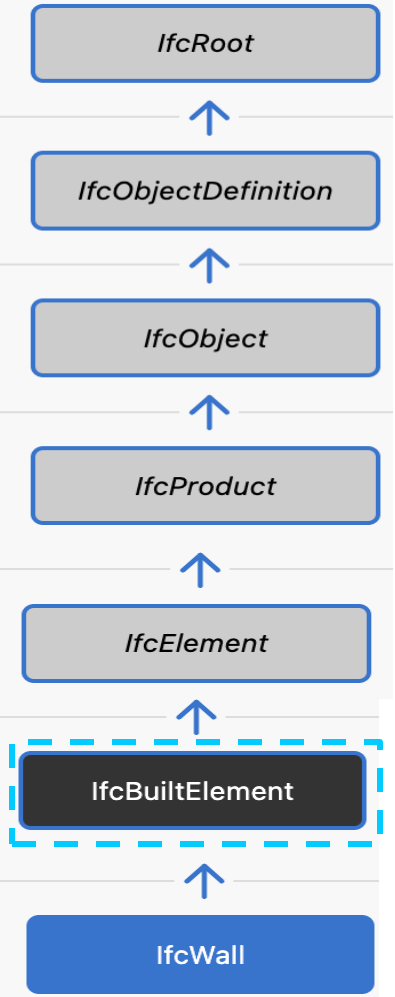
5.4.3.11.2 Entity inheritance





5.4.3.11.3 Attributes

#	Attribute	Type	Description
IfcRoot (4)			
IfcObjectDefinition (7)			
IfcObject (5)			
IfcProduct (5)			
Click to show 21 hidden inherited attributes			
IfcElement (13)			
8	Tag	OPTIONAL IfcIdentifier	The tag (or label) identifier at the particular instance of a product, e.g. the serial number, or the position number. It is the identifier at the occurrence level.
	FillsVoids	SET [0:1] OF IfcRelFillsElement FOR RelatedBuildingElement	Reference to the *IfcRelFillsElement* relationship that puts the element as a filling into the opening created within another element.
	ConnectedTo	SET [0:?] OF IfcRelConnectsElements FOR RelatingElement	Reference to the element connection relationship. The relationship then refers to the other element to which this element is connected to.
	IsInterferedByElements	SET [0:?] OF IfcRelInterferesElements FOR RelatedElement	Reference to the interference relationship to indicate the element that is interfered. The relationship, if provided, indicates that this element has an interference with one or many other elements. NOTE There is no indication of precedence between *IsInterferedByElements* and *InterferesElements*. IFC4-CHANGE New inverse relationship.
	InterferesElements	SET [0:?] OF IfcRelInterferesElements FOR RelatingElement	Reference to the interference relationship to indicate the element that interferes. The relationship, if provided, indicates that this element has an interference with one or many other elements. NOTE There is no indication of precedence between *IsInterferedByElements* and *InterferesElements*. IFC4-CHANGE New inverse relationship.
	HasProjections	SET [0:?] OF IfcRelProjectsElement FOR RelatingElement	Projection relationship that adds a feature (using a Boolean union) to the *IfcBuiltElement*.
	HasOpenings	SET [0:?] OF IfcRelVoidsElement FOR RelatingBuildingElement	Reference to the *IfcRelVoidsElement* relationship that creates an opening in an element. An element can incorporate zero-to-many openings. For each opening, that voids the element, a new relationship *IfcRelVoidsElement* is generated.



#	Attribute	Type	Description
	IsConnectionRealization	SET [0:?] OF IfcRelConnectsWithRealizingElements FOR RealizingElements	Reference to the connection relationship with realizing element. The relationship, if provided, assigns this element as the realizing element to the connection, which provides the physical manifestation of the connection relationship.
	ProvidesBoundaries	SET [0:?] OF IfcRelSpaceBoundary FOR RelatedBuildingElement	Reference to space boundaries by virtue of the objectified relationship *IfcRelSpaceBoundary*. It defines the concept of an element bounding spaces.
	ConnectedFrom	SET [0:?] OF IfcRelConnectsElements FOR RelatedElement	Reference to the element connection relationship. The relationship then refers to the other element that is connected to this element.
	ContainedInStructure	SET [0:1] OF IfcRelContainedInSpatialStructure FOR RelatedElements	Containment relationship to the spatial structure element, to which the element is primarily associated. This containment relationship has to be hierarchical, i.e. an element may only be assigned directly to zero or one spatial structure.
	HasCoverings	SET [0:?] OF IfcRelCoversBldgElements FOR RelatingBuildingElement	Reference to *IfcCovering* by virtue of the objectified relationship *IfcRelCoversBldgElements*. It defines the concept of an element having coverings associated.
	HasSurfaceFeatures	SET [0:?] OF IfcRelAdheresToElement FOR RelatingElement	Reference to the *IfcRelAdheresToElement* relationship that adheres a *IfcSurfaceFeature* to an element. An element can incorporate zero-to-many surface features in one relationship.

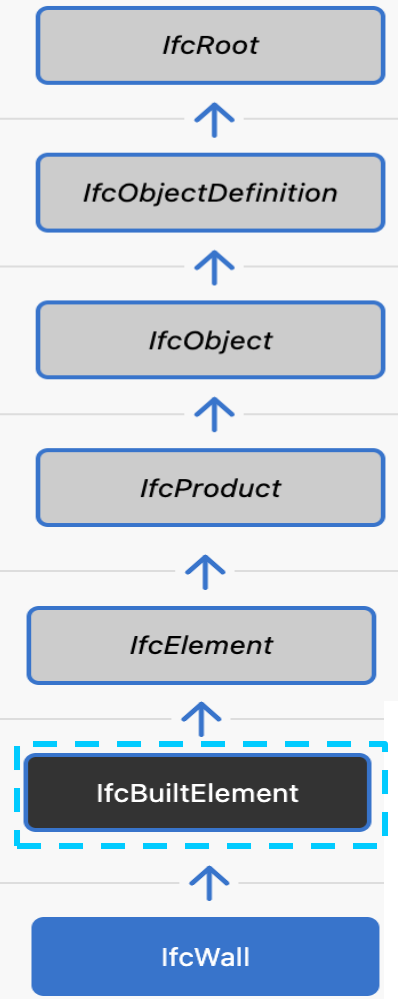
Table 5.4.3.11.G

5.4.3.11.4 Formal propositions

Name	Description
MaxOneMaterialAssociation	There should be only a maximum of one material association assigned to an building element. NOTE The material association can assign a single material, a set of material constituents, a set of material layers, or a set of material profiles by a single association relationship. IFC2X4-CHANGE The where rule has been promoted from the subtype *IfcWall*.

```
SIZEOF (QUERY(temp <* SELF\IfcObjectDefinition.HasAssociations |
  'IFC4X3_ADD2.IFCRELASSOCIATESMATERIAL' IN TYPEOF(temp)
  )) <= 1
```

Table 5.4.3.11.H



IfcBuiltElement

5.4.3.11.5 Property sets

Pset_Condition
AssessmentDate
AssessmentCondition

Pset_ConstructionAdministration
ProcurementMethod
SpecificationSectionNumber

Pset_ConstructionOccurence
InstallationDate
ModelNumber

Pset_ElementKinematics
CyclicPath
CyclicRange

Pset_EnvironmentalCondition
ReferenceAirRelativeHumidity
ReferenceEnvironmentTemperature

Pset_EnvironmentalImpactIndicators
Reference
FunctionalUnitReference

Pset_EnvironmentalImpactValues
TotalPrimaryEnergyConsumption
WaterConsumption

Pset_InstallationOccurrence
InstallationDate
AcceptanceDate

Pset_MaintenanceStrategy
AssetCriticality
AssetFrailty

Pset_MaintenanceTriggerCondition
ConditionTargetPerformance
ConditionMaintenanceLevel

Pset_MaintenanceTriggerDuration
DurationTargetPerformance
DurationMaintenanceLevel

Pset_MaintenanceTriggerPerformance
TargetPerformance
PerformanceMaintenanceLevel

Pset_ManufacturerOccurrence
AcquisitionDate
BarCode

Pset_ManufacturerTypeInformation
GlobalTradeItemNumber
ArticleNumber

Pset_RepairOccurrence
RepairContent
RepairDate

Pset_Risk
RiskName
RiskType

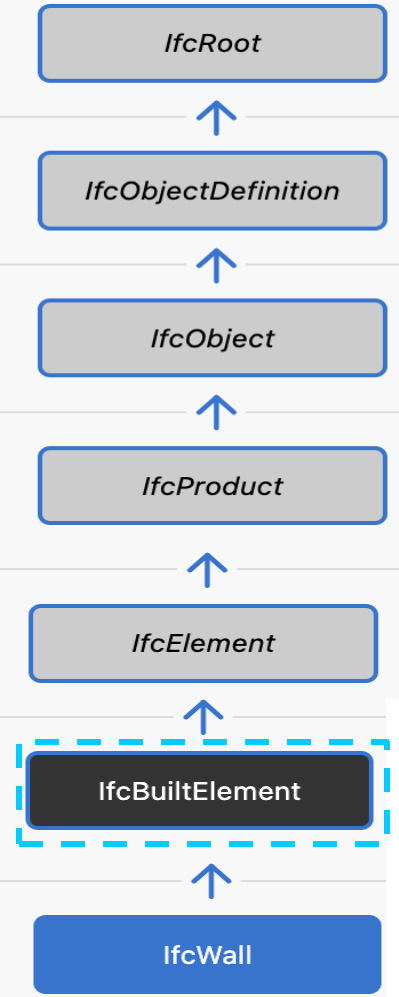
Pset_ServiceLife
ServiceLifeDuration

Pset_Tolerance
ToleranceDescription
ToleranceBasis

Pset_Uncertainty
UncertaintyBasis
UncertaintyDescription

Pset_Warranty
WarrantyIdentifier
WarrantyStartDate

Qto_BodyGeometryValidation
GrossSurfaceArea
NetSurfaceArea



IfcBuiltElement

5.4.3.11.6 Concept usage

Concept	Usage	Description
IfcRoot (2)		
IfcObjectDefinition (9)		
IfcObject (5)		
IfcProduct (18)		
IfcElement (44)		
Click to show 78 hidden inherited concepts		
IfcBuiltElement (3)		
Product Assignment	General	This concept can be applied to the following resources: — IfcTask - Task for operating upon the building element.
Surface 3D Geometry	General	This is a further elaboration on an inherited concept. Some *IfcBuiltElement* may be represented by a surface as an abstract geometric representation. See each subtype for specific guidance.
Object Typing	General	This concept can be applied to the following resources: — IfcBuiltElementType

Table 5.4.3.11.I

5.4.3.11.7 Examples



Figure 5.4.3.11.D

Sectioned Solid Horizontal



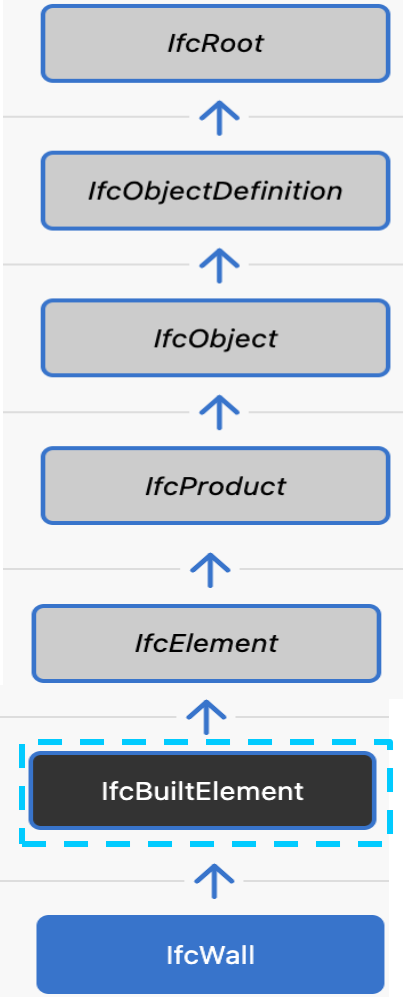
Figure 5.4.3.11.E

Fixed Reference Swept A...



Figure 5.4.3.11.F

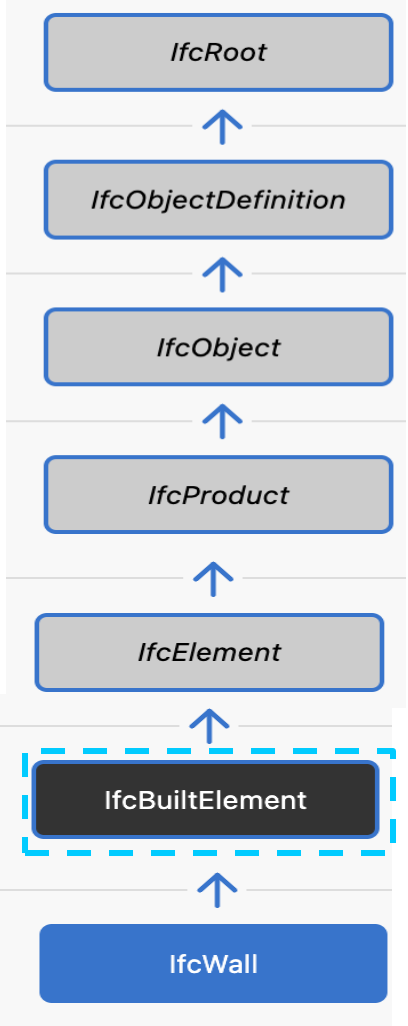
Geographic Referencing ...



IfcBuiltElement

5.4.3.11.8 Formal representation

```
ENTITY IfcBuiltElement
 SUPERTYPE OF (ONEOF
        (IfcBeam
        ,IfcBearing
        ,IfcBuildingElementProxy
        ,IfcChimney
        ,IfcColumn
        ,IfcCourse
        ,IfcCovering
        ,IfcCurtainWall
        ,IfcDeepFoundation
        ,IfcDoor
        ,IfcEarthworksElement
        ,IfcFooting
        ,IfcKerb
        ,IfcMember
        ,IfcMooringDevice
        ,IfcNavigationElement
        ,IfcPavement
        ,IfcPlate
        ,IfcRail
        ,IfcRailing
        ,IfcRamp
        ,IfcRampFlight
        ,IfcRoof
        ,IfcShadingDevice
        ,IfcSlab
        ,IfcStair
        ,IfcStairFlight
        ,IfcTrackElement
        ,IfcWall
        ,IfcWindow))
 SUBTYPE OF (IfcElement);
 WHERE
        MaxOneMaterialAssociation : SIZEOF (QUERY(temp <* SELF\IfcObjectDefinition.HasAssociations |
  'IFC4X3_ADD2.IFCRELASSOCIATESMATERIAL' IN TYPEOF(temp)
  )) <= 1;
END_ENTITY;
```



6.1.3.41 IfcWall

NOTE This entity is a subtype of IfcProduct or IfcTypeProduct and hence part of every standardized schema subset and implementation level.

6.1.3.41.1 Semantic definition

The wall represents a vertical construction that may bound or subdivide spaces. Wall are usually vertical, or nearly vertical, planar elements, often designed to bear structural loads A wall is however not required to be load bearing.

A wall may have openings, such as wall openings, openings used for windows or doors, or niches and recesses. They are defined by an *IfcOpeningElement* attached to the wall using the inverse relationship *HasOpenings* pointing to *IfcRelVoidsElement*. Walls with openings that have already been modeled within the enclosing geometry may use the relationship *IfcRelConnectsElements* to associate the wall with embedded elements such as doors and windows.

There are two main representations for all occurrences:

- *IfcWall* with *IfcMaterialLayerSetUsage* is used for all occurrences of walls, that have a non-changing thickness along the wall path and where the thickness parameter can be fully described by a material layer set. These walls are always represented geometrically by an 'Axis' and a 'SweptSolid' shape representation (or by a 'Clipping' geometry based on 'SweptSolid'), if a 3D geometric representation is assigned.
- *IfcWall* without *IfcMaterialLayerSetUsage* is used for all other occurrences of wall, particularly for walls with changing thickness along the wall path (e.g. polygonal walls), or walls with a non-rectangular cross sections (e.g. L-shaped retaining walls), and walls having an extrusion axis that is unequal to the global Z axis of the project (i.e. non-vertical walls), or walls having only 'Brep', or 'SurfaceModel' geometry, or if a more parametric representation is not intended.

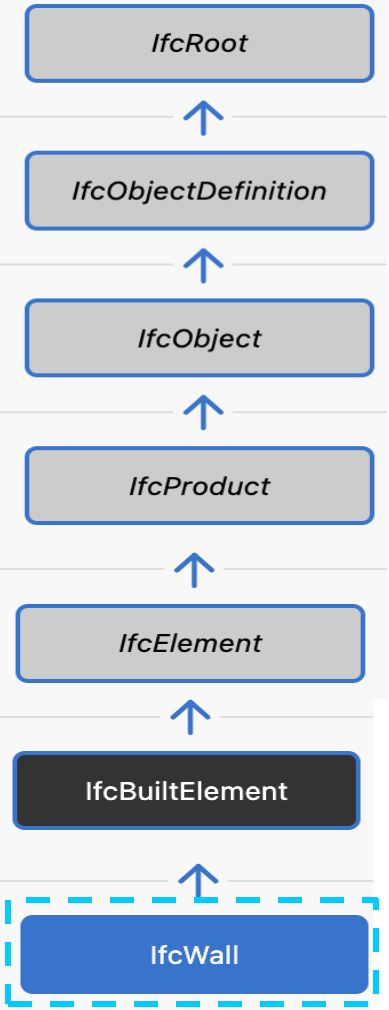
REFERENCE Definition according to ISO 6707-1: vertical construction usually in masonry or in concrete which bounds or subdivides a construction works and fulfils a load bearing or retaining function.

NOTE An arbitrary planar element to which this semantic information is not applicable (is not predominantly vertical), shall be modeled as *IfcPlate*.

NOTE The entity *IfcWallStandardCase* has been deprecated, *IfcWall* with *IfcMaterialLayerSetUsage* is used instead. The entity *IfcWallElementedCase* has been deleted, *IfcWall* with *IfcRelAggregates* is used to describe occurrences of wall which are aggregated from subordinate elements, such as wall panels.

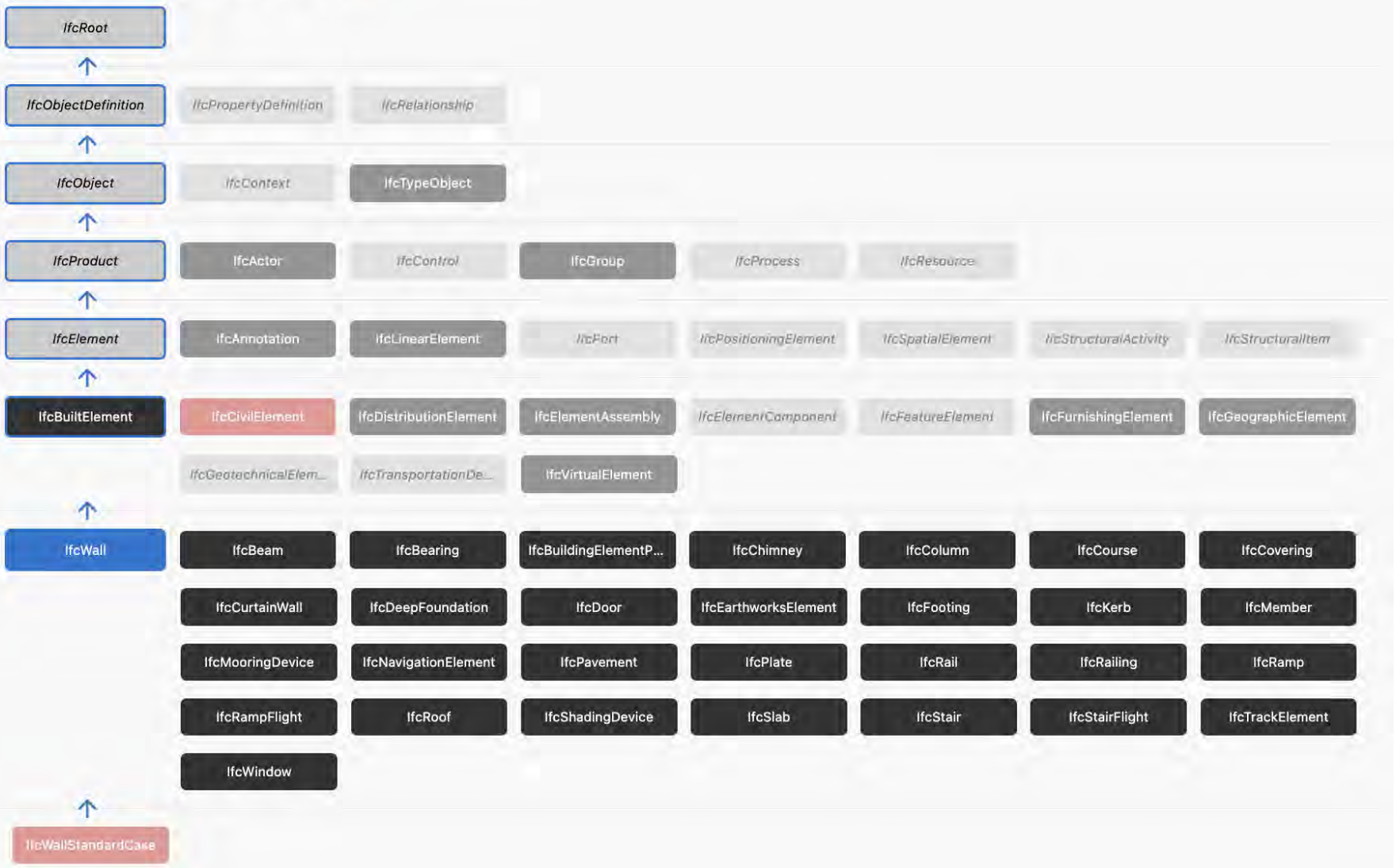
NOTE There is a representation of walls for structural analysis provided by a proper subtype of *IfcStructuralMember* being part of the *IfcStructuralAnalysisModel*.

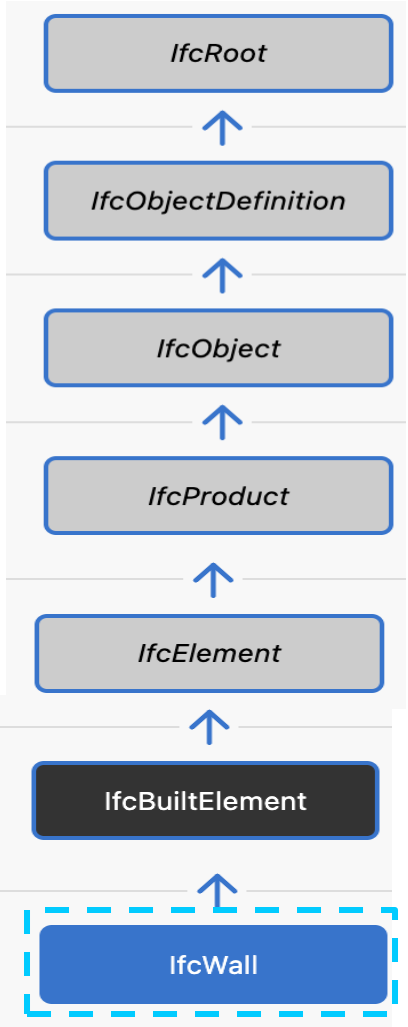
HISTORY New entity in IFC1.0



IfcWall

6.1.3.41.2 Entity inheritance





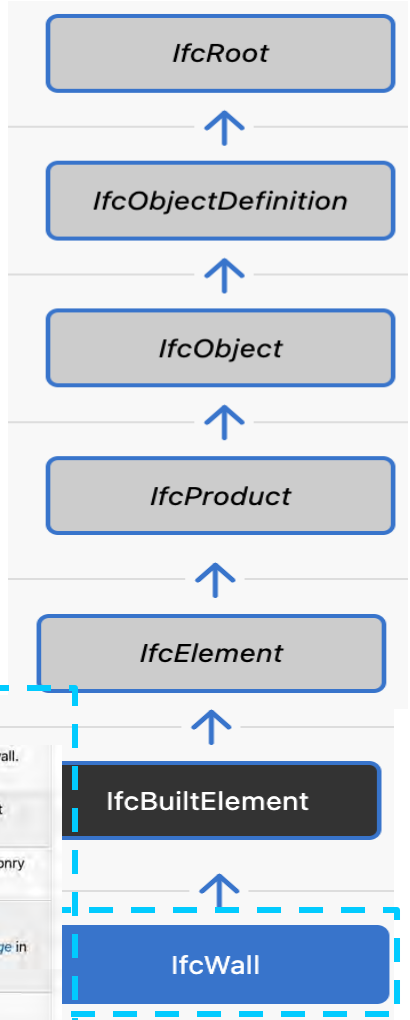
IfcWall

6.1.3.41.3 Attributes

#	Attribute	Type	Description
IfcRoot (4)			
IfcObjectDefinition (7)			
IfcObject (5)			
IfcProduct (5)			
IfcElement (13)			
Click to show 34 hidden inherited attributes			
IfcWall (1)			
9	PredefinedType	OPTIONAL IfcWallTypeEnum	Predefined generic type for a wall that is specified in an enumeration. There may be a property set given specifically for the predefined types. NOTE The *PredefinedType* shall only be used, if no *IfcWallType* is assigned, providing its own *IfcWallType.PredefinedType*. IFC4-CHANGE The attribute has been added at the end of the entity definition.

Table 6.1.3.41.P

Type	Description
ELEMENTEDWALL	A stud wall framed with studs and faced with sheetings, sidings, wallboard, or plasterwork. IFC4.3.2.0-CHANGE This enumeration value is no longer deprecated. NOTE An elemented wall can be modelled by means of an aggregation of various components (use *IfcRelAggregates* to relate to the *IfcWall*), but when this amount of detail is not necessary or available this enumeration value can be used instead.
MOVABLE	A movable wall that is either movable, such as folding wall or a sliding wall, or can be easily removed as a removable partitioning or mounting wall. Movable walls do normally not define space boundaries and often belong to the furnishing system.
PARAPET	A wall-like barrier to protect human or vehicle from falling, or to prevent the spread of fires. Often designed at the edge of balconies, terraces or roofs, or along edges of bridges.
PARTITIONING	A wall designed to partition spaces that often has a light-weight, sandwich-like construction (e.g. using gypsum board). Partitioning walls are normally non load bearing.
PLUMBINGWALL	A pier, or enclosure, or encasement, normally used to enclose plumbing in sanitary rooms. Such walls often do not extend to the ceiling.
POLYGONAL	A polygonal wall, extruded vertically, where the wall thickness varies along the wall path. IFC4-DEPRECATION The value is deprecated and shall no longer be used.
RETAININGWALL	A supporting wall used to protect against soil layers behind. Special types of a retaining wall may be e.g. Gabion wall and Grib wall. Examples of retaining walls are wing wall, headwall, stem wall, pierwall and protecting wall.
SHEAR	A wall designed to withstand shear loads. Examples of shear wall are diaphragms inside a box girder, typically on a pier, to resist lateral forces and transfer them to the support.
SOLIDWALL	A massive wall construction for the wall core being the single layer or having multiple layers attached. Such walls are often masonry or concrete walls (both cast in-situ or precast) that are load bearing and fire protecting.
STANDARD	A standard wall, extruded vertically with a constant thickness along the wall path. IFC4-DEPRECATION The value is deprecated, it is expressed by using an *IfcMaterialLayerSet* with *IfcMaterialLayerSetUsage* in occurrences.
WAVEWALL	Protective wall or screen to block overtopping and impact of waves across a breakwater
USERDEFINED	User-defined wall element.
NOTDEFINED	Undefined wall element.



6.1.3.41.5 Property sets

Pset_ConcreteElementGeneral
AssemblyPlace
CastingMethod
StructuralClass

Pset_Condition
AssessmentDate
AssessmentCondition
AssessmentDescription

Pset_ConstructionAdministration
ProcurementMethod
SpecificationSectionNumber
SubmittalIdentifer

Pset_ConstructionOccurence
InstallationDate
ModelNumber
TagNumber

Pset_ElementKinematics
CyclicPath
CyclicRange
LinearPath

Pset_EnvironmentalCondition
ReferenceAirRelativeHumidity
ReferenceEnvironmentTemperature
MaximumAtmosphericPressure

Pset_EnvironmentalImpactIndicators
Reference
FunctionalUnitReference
IndicatorsUnit

Pset_EnvironmentalImpactValues
TotalPrimaryEnergyConsumption
WaterConsumption
HazardousWaste

Pset_InstallationOccurrence
InstallationDate
AcceptanceDate
PutIntoOperationDate

Pset_MaintenanceStrategy
AssetCriticality
AssetFrailty
AssetPriority

Pset_MaintenanceTriggerCondition
ConditionTargetPerformance
ConditionMaintenanceLevel
ConditionReplacementLevel

Pset_MaintenanceTriggerDuration
DurationTargetPerformance
DurationMaintenanceLevel
DurationReplacementLevel

Pset_MaintenanceTriggerPerformance
TargetPerformance
PerformanceMaintenanceLevel
ReplacementLevel

Pset_ManufacturerOccurrence
AcquisitionDate
BarCode
SerialNumber

Pset_ManufacturerTypeInformation
GlobalTradeItemNumber
ArticleNumber
ModelReference

Pset_PrecastConcreteElementFabrication
TypeDesignation
ProductionLotId
SerialNumber

Pset_PrecastConcreteElementGeneral
TypeDesignation
CornerChamfer
ManufacturingToleranceClass

Pset_ReinforcementBarPitchOfWall
Description
Reference
BarAllocationType

Pset_RepairOccurrence
RepairContent
RepairDate
MeanTimeToRepair

Pset_Risk
RiskName
RiskType
NatureOfRisk

Pset_RoadGuardElement PARAPET
IsMoveable
IsTerminal
IsTransition

Pset_ServiceLife
ServiceLifeDuration
MeanTimeBetweenFailure

Pset_Tolerance
ToleranceDescription
ToleranceBasis
OverallTolerance

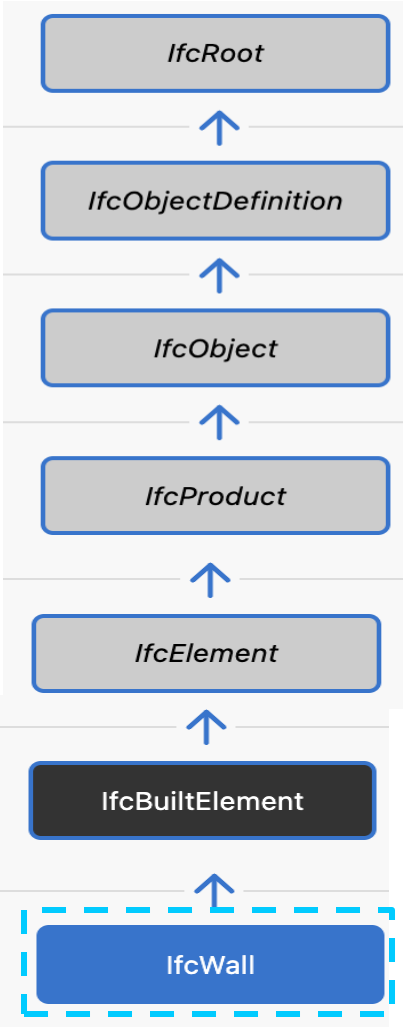
Pset_Uncertainty
UncertaintyBasis
UncertaintyDescription
HorizontalUncertainty

Pset_WallCommon
Reference
Status
AcousticRating

Pset_Warranty
WarrantyIdentifier
WarrantyStartDate
IsExtendedWarranty

Qto_BodyGeometryValidation
GrossSurfaceArea
NetSurfaceArea
GrossVolume

Qto_WallBaseQuantities
Length
Width
Height



6.1.3.41.6 Concept usage

Concept	Usage	Description
IfcRoot (2)		
IfcObjectDefinition (9)		
IfcObject (5)		
IfcProduct (18)		
IfcElement (44)		
IfcBuiltElement (3)		
Click to show 81 hidden inherited concepts		
IfcWall (15)		
Axis 2D Geometry	General	The wall axis is represented by a two-dimensional open curve within a particular shape representation. The 'Axis' shape representation is only used to locate the material layer set along the axis, if the *IfcMaterialLayerSetUsage* is applied to the *IfcWall*. In this case, the wall axis is used to apply the material layer set usage parameter to the wall geometry. — Axis — *IfcPolyline* having two Points, or *IfcTrimmedCurve* with *BasisCurve* of Type *IfcLine* for the 'SweptSolid' provided as *IfcExtrudedAreaSolid*. The axis curve lies on the x/y plane and is parallel to the x-axis of the object coordinate system. — *IfcTrimmedCurve* with *BasisCurve* of Type *IfcCircle* for 'SweptSolid' provided as *IfcExtrudedAreaSolid*. The axis curve lies on the x/y plane of the object coordinate system, the tangent at the start is along the positive x-axis.

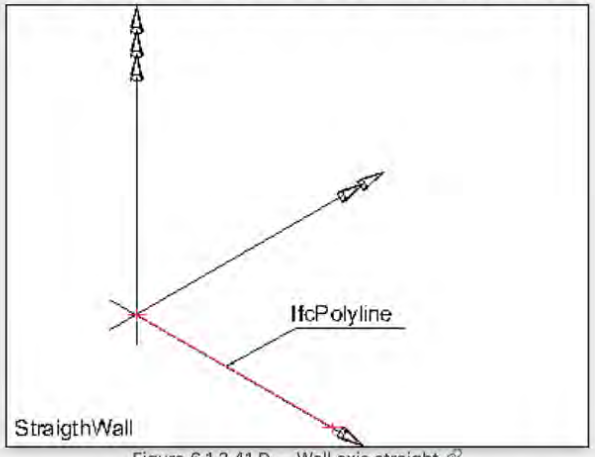
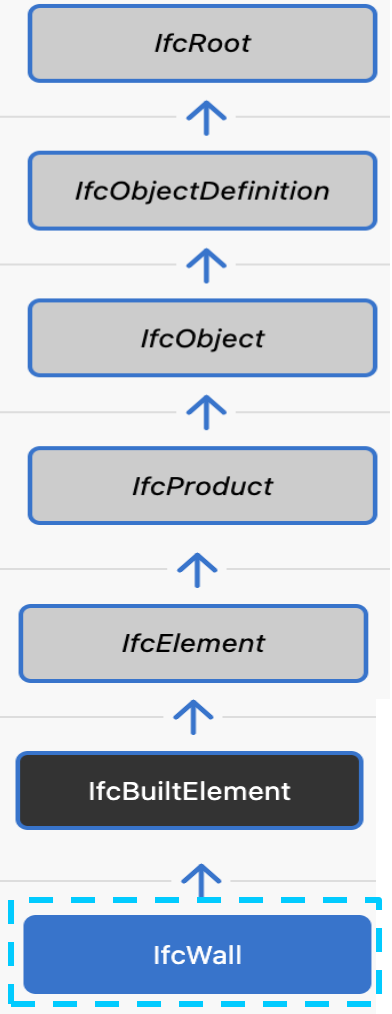


Figure 6.1.3.41.D — Wall axis straight

Figure 6.1.3.41.D illustrates an axis representation for a straight wall. In case of a straight wall, the set of items shall include a single geometric representation item of type *IfcPolyline* or *IfcTrimmedCurve* with the *BasisCurve* being an *IfcLine*. The *IfcPolyline* or *IfcTrimmedCurve* shall be parallel (here in a special case co-linear) to the x-axis of the object coordinate system. The direction shall be identical to the direction of the x-axis.



Concept	Usage	Description

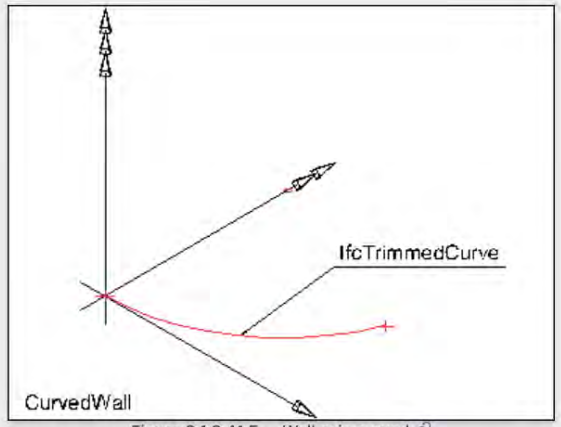


Figure 6.1.3.41.E — Wall axis curved

Figure 6.1.3.41.E illustrates an axis representation for a curved wall. In case of a curved wall, the set of items shall include a single geometric representation item of type *IfcTrimmedCurve*. The curve shall have a *BasisCurve* of type *IfcCircle*. The tangent of the *IfcTrimmedCurve* shall be parallel at start to the x-axis of the object coordinate system. The direction shall be identical to the direction of the x-axis.

Body Clipping Geometry	General	This is a further elaboration on an inherited concept.

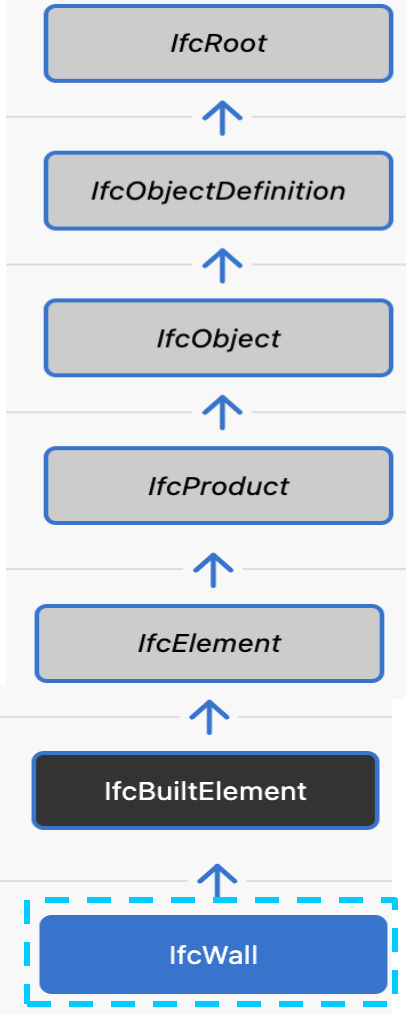
The following additional constraints apply to the 'SweptSolid' representation, when an *IfcMaterialLayerSetUsage* is assigned to the *IfcSlab*:

— Solid: *IfcExtrudedAreaSolid* is required
— Profile: *IfcArbitraryClosedProfileDef* and *IfcRectangleProfileDef* shall be supported.
— Extrusion: All extrusion directions shall be supported.
— Boolean result: The *IfcBooleanClippingResult* shall be supported, allowing for Boolean differences between the swept solid (here *IfcExtrudedAreaSolid*) and one or several *IfcHalfSpaceSolid* (or subtypes).

Figure 6.1.3.41.F illustrates a clipping for a straight wall using an *IfcPolygonalBoundedHalfSpace* as *SecondOperand* in the *IfcBooleanClippingResult*.



Figure 6.1.3.41.F — Wall body clipping straight



Concept	Usage	Description

Figure 6.1.3.41.G illustrates a clipping for a curved wall using an *IfcHalfSpaceSolid* as *SecondOperand* in the *IfcBooleanClippingResult*.

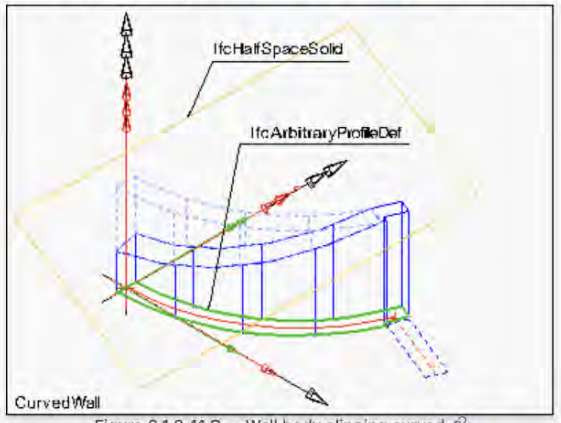


Figure 6.1.3.41.G — Wall body clipping curved

Body SweptSolid Geometry	General	This is a further elaboration on an inherited concept.

The following additional constraints apply to the 'SweptSolid' representation:

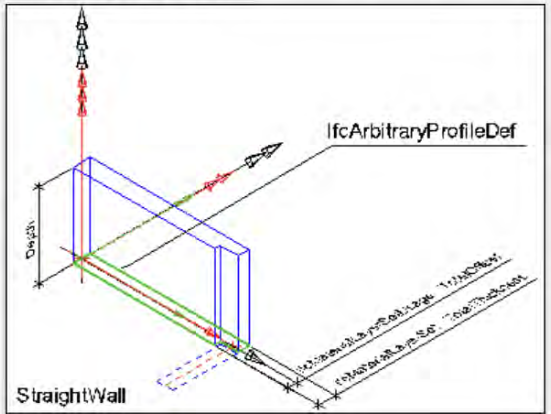
— Solid: *IfcExtrudedAreaSolid* is required
— Profile: *IfcArbitraryClosedProfileDef* and *IfcRectangleProfileDef* shall be supported.
— Extrusion: All extrusion directions shall be supported.

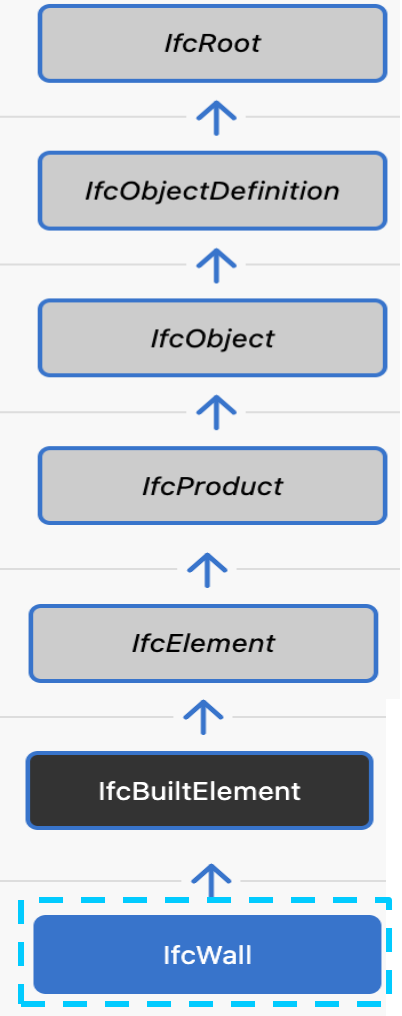
Additional constraints apply to the 'SweptSolid' representation, when an *IfcMaterialLayerSetUsage* is used:

— Extrusion: The profile shall be extruded vertically, i.e., in the direction of the z-axis of the coordinate system of the referred spatial structure element. It might be further constraint to be in the direction of the global z-axis in implementers agreements. The extrusion axis shall be perpendicular to the swept profile, i.e. pointing into the direction of the z-axis of the *Position* of the *IfcExtrudedAreaSolid*.

The profile of a wall is described in the ground view and extruded vertically. The profile (also identical with the foot print of the wall) is defined by the *IfcArbitraryClosedProfileDef* (excluding its subtypes). The profile is given with all wall connections already resolved.

Figure 6.1.3.41.H illustrates a body representation for a straight wall. In case of a straight wall, the two sides of the profile shall be parallel to the wall axis, that is, the wall has a single unchanged thickness.





Concept	Usage	Description

Figure 6.1.3.41.I illustrates a body representation for a curved wall. In case of a curved wall, the two sides of the profile shall be parallel (with defined offset) to the wall axis, that is, the wall has a single unchanged thickness.

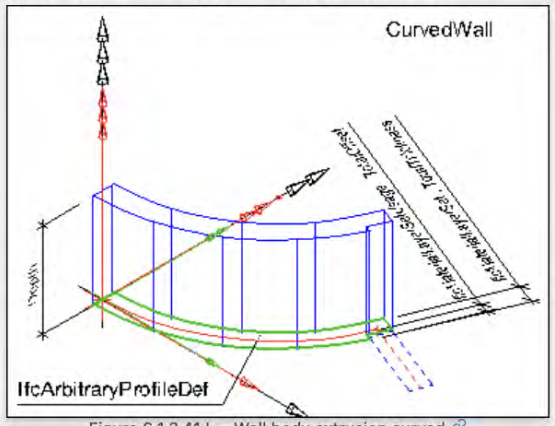


Figure 6.1.3.41.I — Wall body extrusion curved

Element Decomposition	General	A wall may decomposed into parts such as framing and panels on each side. For efficiency, each part may reuse geometry using the mapped geometry concept.

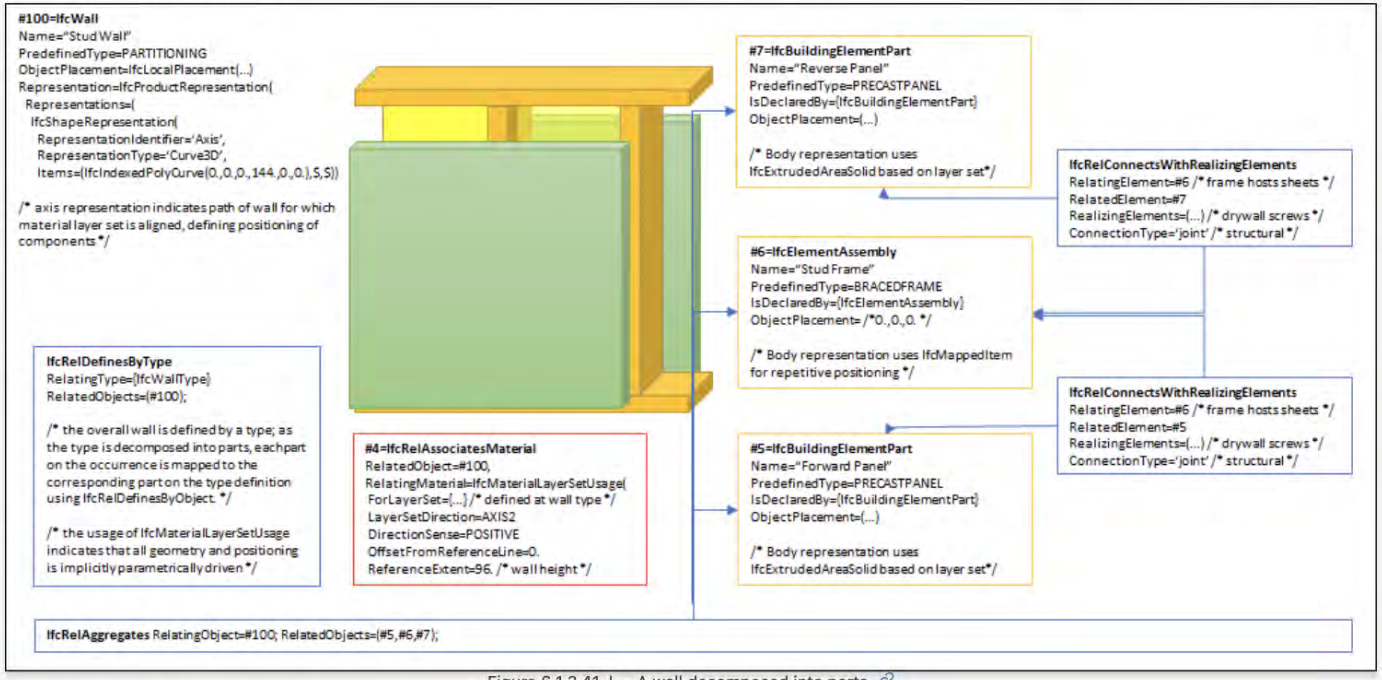
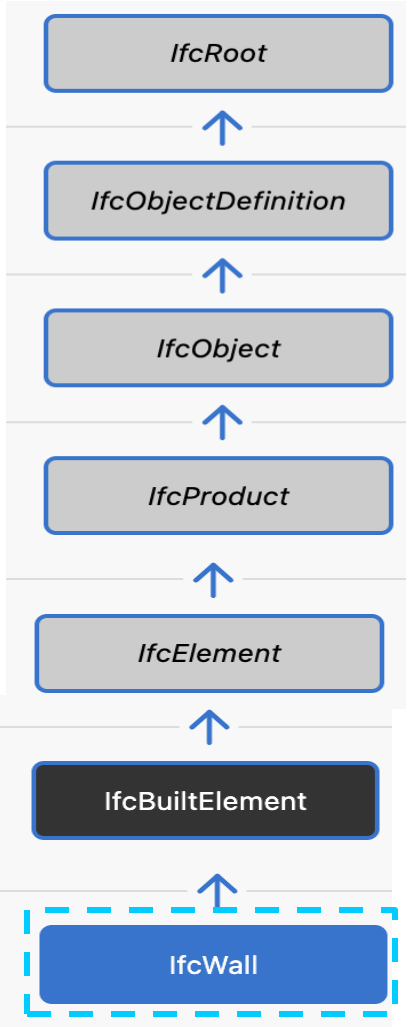
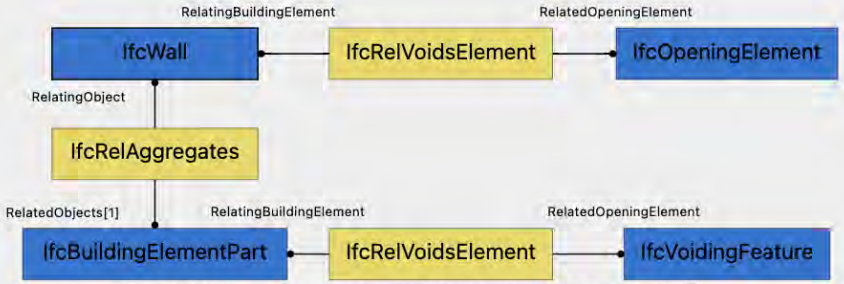
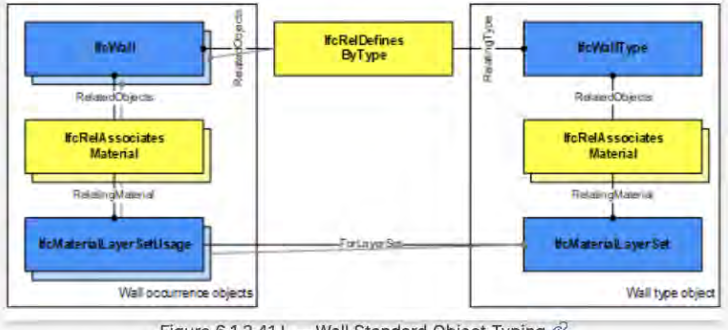


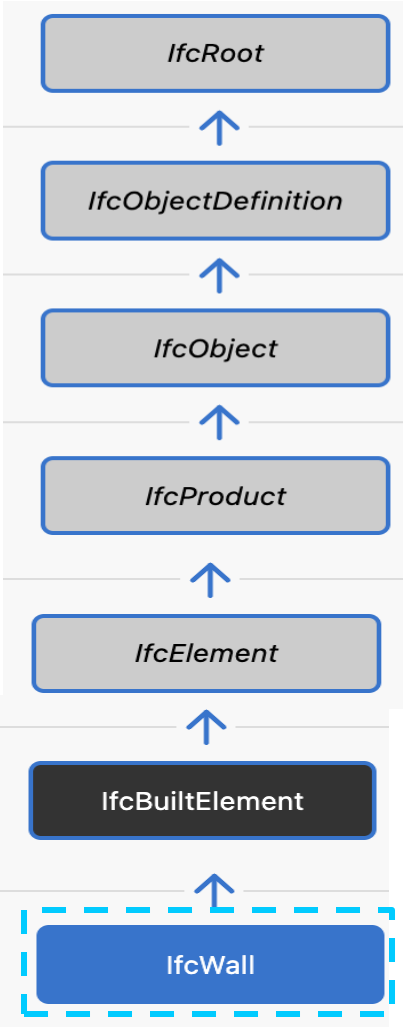
Figure 6.1.3.41.J — A wall decomposed into parts.

This concept can be applied to the following resources:

— IfcMember - Studs, posts and similar elements
— IfcMechanicalFastener - Fasteners that may be used to connect elements together with IfcRelConnectsWithRealizingElements



Concept	Usage	Description
Element Voiding	General	This is a further elaboration on an inherited concept. As shown in Figure 6.1.3.41.K, openings within the composite wall are directly assigned to *IfcWall* using *IfcRelVoidsElement* pointing to *IfcOpeningElement* and apply to all aggregated parts. If individual parts have cutting and other voiding features, then the decomposed parts have a separate voiding relationship *IfcRelVoidsElement* pointing to *IfcVoidingFeature*.  Figure 6.1.3.41.K — How individual parts being cut may be expressed.
Material Layer Set Usage	General	Figure 6.1.3.41.L illustrates assignment of *IfcMaterialLayerSetUsage* and *IfcMaterialLayerSet* to the *IfcWallType* and the *IfcWall* occurrence.  Figure 6.1.3.41.L — Wall Standard Object Typing Figure 6.1.3.41.M illustrates material layer usage, where: — The reference coordinate system is the local coordinate system established by the *ObjectPlacement* of the *IfcWall*. — The reference axis is the axis defined by the *IfcShapeRepresentation* with *RepresentationType*='Axis' as one of the wall's representations. — The *IfcMaterialLayerSetUsage.OffsetFromReferenceLine* is given as a distance from this axis. — The *IfcMaterialLayerSetUsage.OffsetFromReferenceLine* is the distance parallel to the reference axis and always within the base (XY) plane of the reference coordinate system. A positive value of *IfcMaterialLayerSetUsage.OffsetFromReferenceLine* would then point into the positive y-axis of the reference coordinate system. — The *IfcMaterialLayerSetUsage.DirectionSense* defines how the *IfcMaterialLayer*'s are assigned to the reference axis. POSITIVE means in direction to the positive y-axis of the reference coordinate system. — The *Thickness* of each *IfcMaterialLayer* is provided starting from the *OffsetFromReferenceLine* and in the direction given by *DirectionSense*. It is applied without any gap or overlap between two consecutive layers. The *TotalThickness* of the *IfcMaterialLayerSet* is the sum of all layer thicknesses. — The *IfcMaterialLayerSetUsage.LayerSetDirection* is always AXIS2. — The local placement of the wall uses the the x/y plane for the profile, and the z-axis as the extrusion direction for the wall body.



Concept	Usage	Description

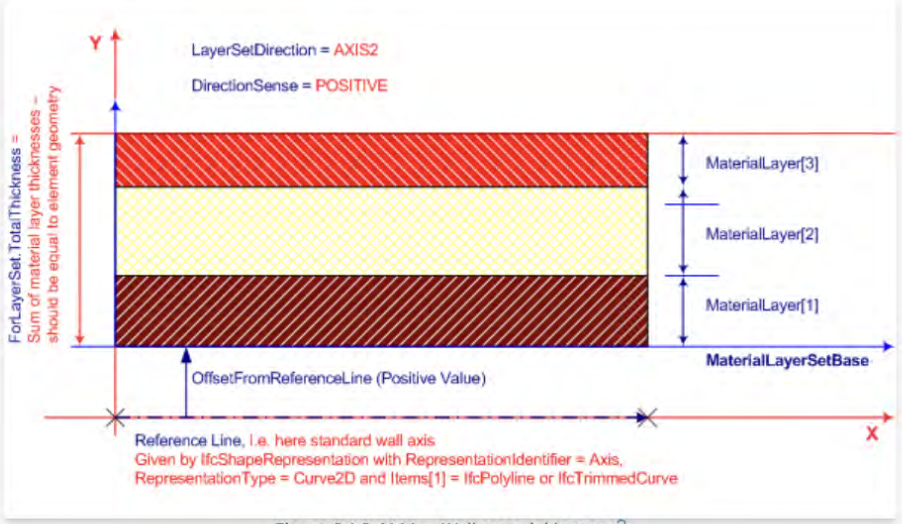
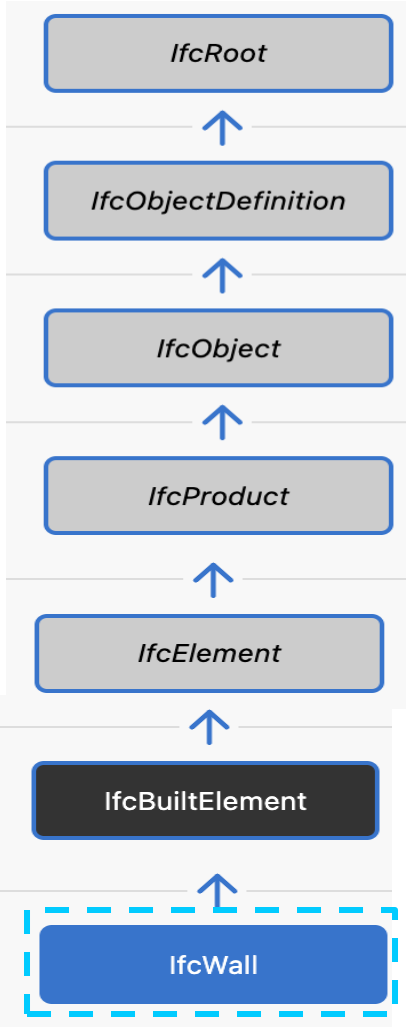


Figure 6.1.3.41.M — Wall material layers

Object Typing	General	This is a further elaboration on an inherited concept. This concept can be applied to the following resources: — IfcWallType
Path Connectivity	General	This concept can be applied to the following resources: — IfcWall - Walls with equal or lower priority are connected at RelatedElement.
Product Assignment	General	This is a further elaboration on an inherited concept. This concept can be applied to the following resources: — IfcStructuralSurfaceMember - An idealized structural member corresponding to the wall. — IfcTask - A task for operating on the wall.
Property Sets for Objects	General	This is a further elaboration on an inherited concept. This concept can be applied to the following resources: — Pset_ConcreteElementGeneral — Pset_PrecastConcreteElementFabrication — Pset_PrecastConcreteElementGeneral — Pset_RoadGuardElement (only applies to `PARAPET`) — Pset_ReinforcementBarPitchOfWall — Pset_WallCommon



Concept	Usage	Description
Quantity Sets	General	This is a further elaboration on an inherited concept. This concept can be applied to the following resources: — Qto_WallBaseQuantities
Spatial Containment	General	This is a further elaboration on an inherited concept. The *IfcWall*, as any subtype of *IfcBuiltElement*, may participate alternatively in one of the two different containment relationships: — the *Spatial Containment* (defined here), or — the *Element Composition*.
Surface Geometry	General	This is a further elaboration on an inherited concept. The 'Surface' can be used to define a surfacic model of the building (e.g. for analytical purposes, or for reduced Level of Detail representation).
Element Openings	General	This concept can be applied to the following resources: — IfcDoor — IfcWindow
Material Set	General	This concept can be applied to the following resources: — LoadBearing — Insulation

Table 6.1.3.41.R

6.1.3.41.7 Examples



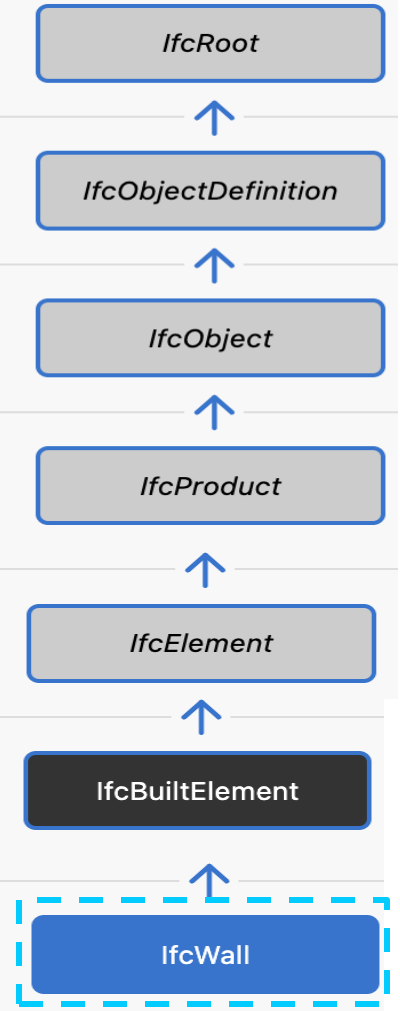
Figure 6.1.3.41.N

Wall Extrusion



Figure 6.1.3.41.O

Construction Scheduling...



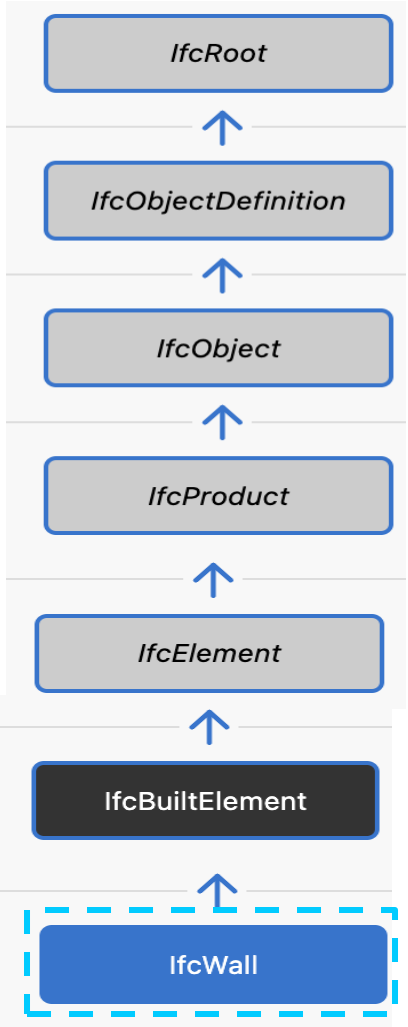
IfcWall

6.1.3.41.8 Formal representation

```
ENTITY IfcWall
 SUPERTYPE OF (ONEOF
       (IfcWallStandardCase))
 SUBTYPE OF (IfcBuiltElement);
       PredefinedType : OPTIONAL IfcWallTypeEnum;
 WHERE
       CorrectPredefinedType : NOT(EXISTS(PredefinedType)) OR
 (PredefinedType <> IfcWallTypeEnum.USERDEFINED) OR
 ((PredefinedType = IfcWallTypeEnum.USERDEFINED) AND EXISTS (SELF\IfcObject.ObjectType));
       CorrectTypeAssigned : (SIZEOF(IsTypedBy) = 0) OR
  ('IFC4X3_ADD2.IFCWALLTYPE' IN TYPEOF(SELF\IfcObject.IsTypedBy[1].RelatingType));
END_ENTITY;
```

6.1.3.41.9 References

IfcBuiltElement
IfcWallStandardCase




IFC Building Element Proxy

6.1.3.5 IfcBuildingElementProxy

NOTE This entity is a subtype of IfcProduct or IfcTypeProduct and hence part of every standardized schema subset and implementation level.

6.1.3.5.1 Semantic definition

The *IfcBuildingElementProxy* is a proxy definition that provides the same functionality as subtypes of *IfcBuiltElement*, but without having a predefined meaning of the special type of building element it represents.

IfcBuildingElementProxy may be used:

— To exchange special types of building elements for which the current specification does not yet provide a semantic definition.
— To represent building elements for which the participating applications can not provide a semantic definition.

IFC4.3.0.0-CHANGE *IfcBuildingElementProxy* should no longer be used as spatial placeholders or provisions. Use *IfcVirtualElement* instead.

HISTORY New entity in IFC2x.



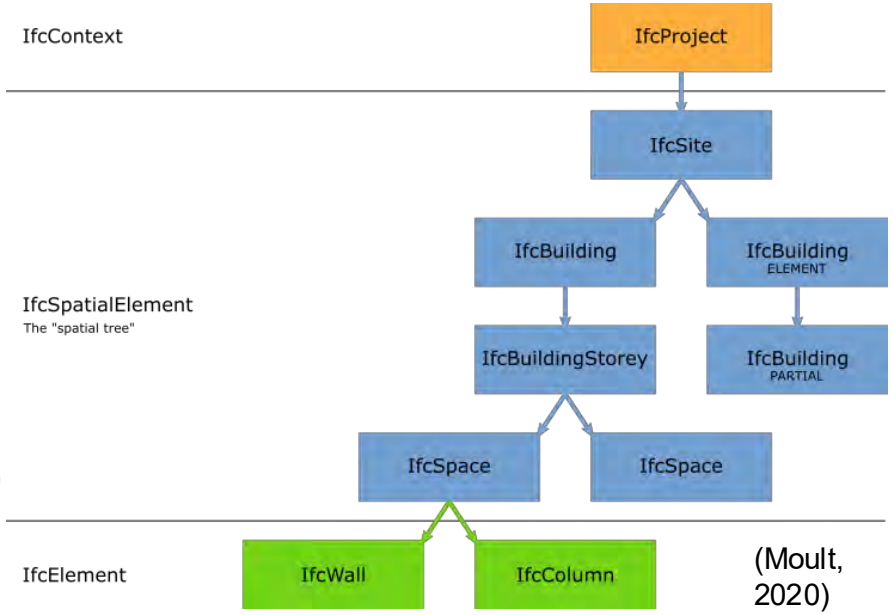


IFC spatial structure

The **Spatial Structure** organises the model into hierarchical levels, making it possible to understand 'where' each element is inserted.

Main spatial entities:

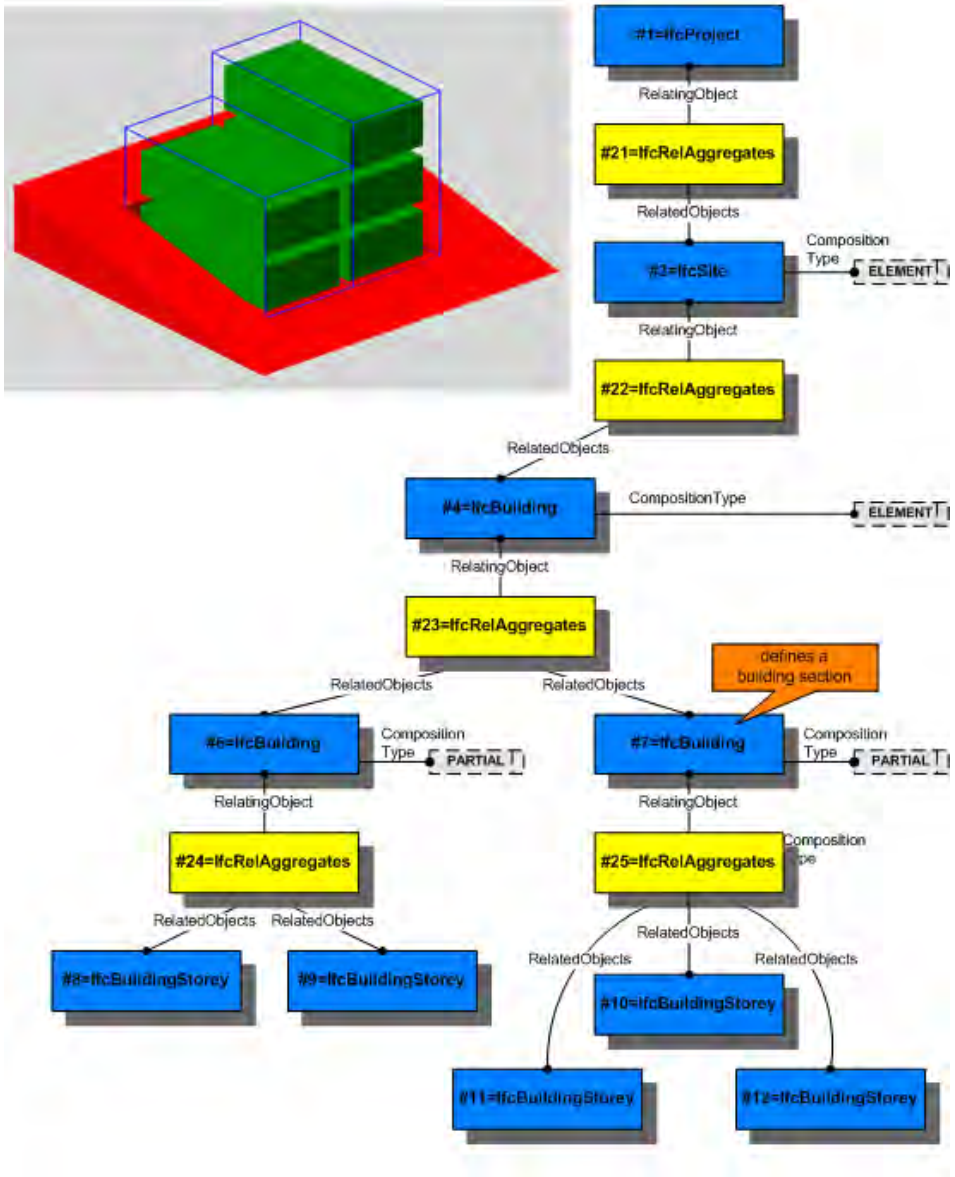
1. **IFCProject** (project as a whole)
2. **IFCSite** (land or area)
3. **IFCFacility/IFCBuilding** (building, road, bridge, tunnel, etc.)
4. **IFCFacilityPart** / **IFCBuildingStorey** (vertical subdivisions or sections)
5. **IFCAlignment** / **IFCSpace** / etc. (depending on the type of development)



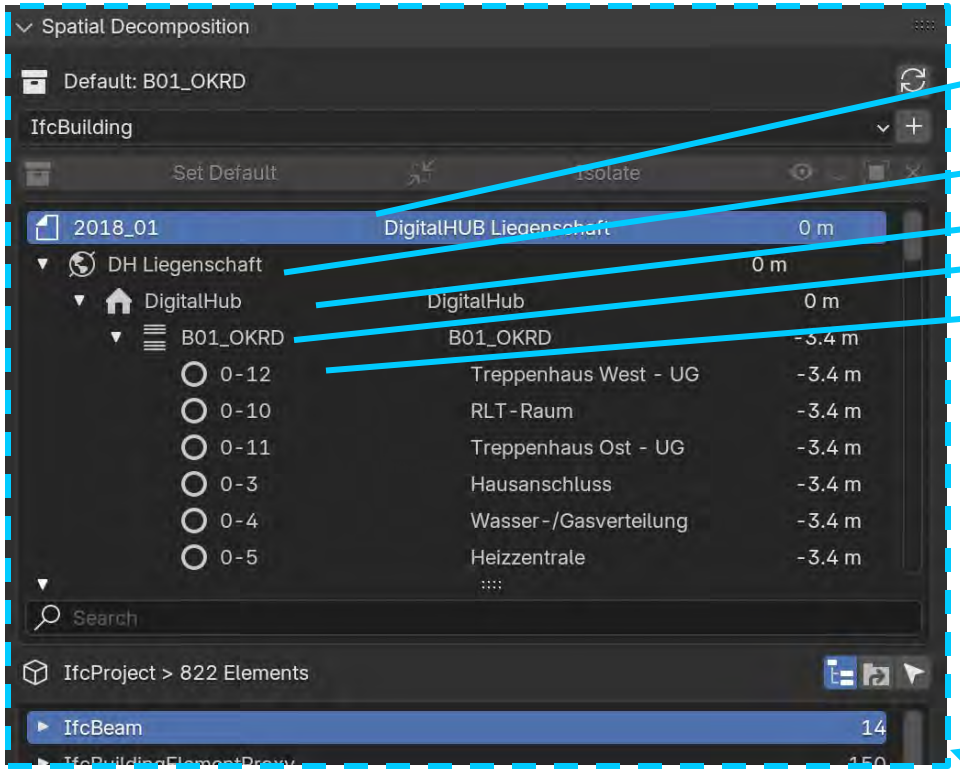
(Moult, 2020)

IFCProject
└ IFCSite
└ IFCFacility/IFCBuilding (building, road, bridge, tunnel, etc.)
└ IFCFacilityPart / IFCBuildingStorey / IFCBridgePart...
└ IFCElement (physical components: walls, beams, runway, etc.)

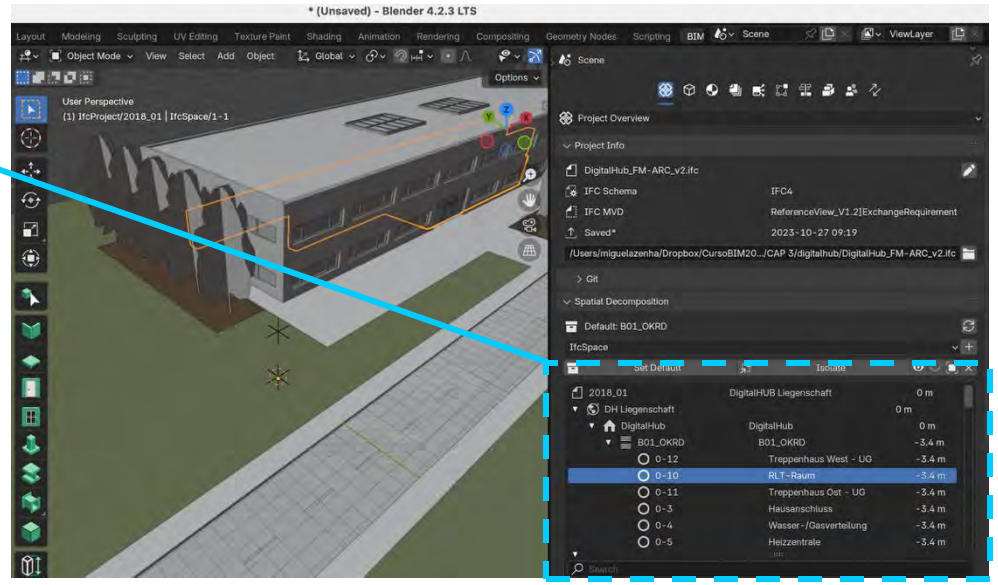
Spatial organisation of IFC



IFC Spatial structure - Case of buildings



- IFCProject
  - IFCSite
    - IFCBuilding (Ex: Office building)
      - IFCBuildingStorey (Ground floor)
        - IFCSpace (Ex: Reception, WC, Meeting Room)
      - IFCBuildingStorey (1st Floor)
        - IFCSpace (Offices, Corridor)
      - IFCBuildingStorey (2nd Floor)
        - IFCSpace (Computer rooms, storage)



Georeferencing in IFC

https://www.dgterritorio.gov.pt/geodesia/sistemas-referencia/portugal-continental/PT-TM06-ETRS89

https://www.dgterritorio.gov.pt/geodesia/sistemas-referencia

https://epsg.io/3763
PT-TM-06/ETRS89

Reference ellipsoid:	GRS80 — Semi-major axis: a = 6 378 137 m; Flattening: f = 1 / 298.257 222 101
Cartographic projection:	Transverse Mercator
Latitude of the origin of rectangular coordinates:	39º 40' 05",73 N
Longitude of the origin of rectangular coordinates:	08º 07' 59",19 W
False origin of rectangular coordinates:	In M (distance from Meridian): 0 m In P (distance from Perpendicular): 0 m
Scale reduction coefficient at the central meridian:	1.0



The coordinate point M=0; P=0 is slightly offset from the Vila de Rei/Melriça geodesic landmark...

https://epsg.io/map#srs=3763&x=0.000000&y=0.000000&z=19&layer=satellite

IfcProjectedCRS

8.18.3.11 IfcProjectedCRS

8.18.3.11.1 Semantic definition

IfcProjectedCRS is a coordinate reference system (CRS) of the map to which the map translation of the local engineering coordinate system of the construction or facility engineering project relates. The projected coordinate reference system is assumed to be a 2D or 3D right-handed Cartesian coordinate system, the optional *MapUnit* attribute can be used to determine the length unit used by the map.

Despite what its name suggests:

- If the referenced *IfcGeometricRepresentationContext* is 3D, then *IfcProjectedCRS* shall be a **compound coordinate reference system**, meaning a combination of multiple CRS from which a *GeodeticDatum* and a *VerticalDatum* can always be unambiguously identified.
- If the referenced *IfcGeometricRepresentationContext* is 2D, then *IfcProjectedCRS* can be either a **projected coordinate reference system** or a **compound coordinate reference system**.

EXAMPLE The code EPSG:9286 (ETRS89 + NAP height) is the combination of a geographic CRS (ETRS89) and a vertical CRS (NAP height), with their respective datums.

8.18.3.11.2 Entity inheritance



IfcProjectedCRS

8.18.3.11.3 Attributes

#	Attribute	Type	Description
IfcCoordinateReferenceSystem (5)			
			Click to show 5 hidden inherited attributes
IfcProjectedCRS (4)			
4	VerticalDatum	OPTIONAL 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:
5	MapProjection	OPTIONAL IfcIdentifier	Name by which the map projection is identified. EXAMPLE map projections include:
6	MapZone	OPTIONAL IfcIdentifier	Name by which the map zone, relating to the *MapProjection*, is identified. EXAMPLE map zones includes:
7	MapUnit	OPTIONAL 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. NOTE If MapUnit is omitted, the unit for the coordinate axes is taken from the default units, as stated in IfcProject.UnitInContext.

Table 8.18.3.11.D

```
'ETRS89 / PT-TM06',          -- Name (1)
'EPSG:3763 - Portugal Mainland',  -- Description (2)
'ETRS89',                    -- GeodeticDatum (3)
'Mean Sea Level',            -- VerticalDatum (4) ou '$' se não quiser definir
'Transverse Mercator',       -- MapProjection (5)
'EPSG:3763',                 -- MapZone (6)
'm'                          -- MapUnit (7)
```

8.18.3.11.4 Formal propositions

Name	Description
MapUnitIsLength	*No description available.*

```
NOT(EXISTS(SELF.MapUnit)) OR (SELF.MapUnit.UnitType = IfcUnitEnum.LENGTHUNIT)
```

Table 8.18.3.11.E

8.18.3.11.6 Formal representation

```
ENTITY IfcProjectedCRS
 SUBTYPE OF (IfcCoordinateReferenceSystem);
        VerticalDatum : OPTIONAL IfcIdentifier;
        MapProjection : OPTIONAL IfcIdentifier;
        MapZone : OPTIONAL IfcIdentifier;
        MapUnit : OPTIONAL IfcNamedUnit;
 WHERE
        MapUnitIsLength : NOT(EXISTS(SELF.MapUnit)) OR (SELF.MapUnit.UnitType = IfcUnitEnum.LENGTHUNIT);
END_ENTITY;
```

8.18.3.6 IfcMapConversion

8.18.3.6.1 Semantic definition

The map conversion deals with transforming the local engineering coordinate system, often called world coordinate system, into the coordinate reference system of the underlying map.

NOTE The *IfcMapConversion* does not handle the projection of a map from the geodetic coordinate reference system.

For this transformation, *IfcMapConversion* data are used for: 1. a scaling of the three axes (x,y,z), by the same *IfcMapConversion.Scale* 2. followed by an **anti-clockwise** rotation about the z-axis of θ, where:

$$ \theta=arctan\left(\frac{IfcMapConversion.XAxisOrdinate}{IfcMapConversion.XAxisAbscissa}\right) $$

1. and then a translation in (x,y,z) of *IfcMapConversion.Eastings*, *IfcMapConversion.Northings*, *IfcMapConversion.OrthogonalHeight*

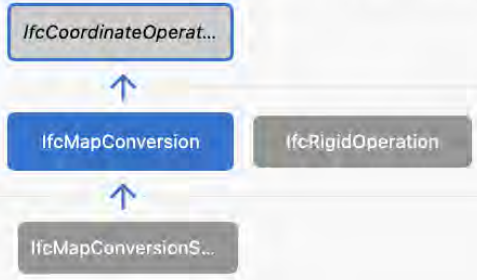
With *IfcMapConversion*, **one scale** is applied equally to x, y and z, **to convert units**. With *IfcMapConversionScaled*, additional **different factors** multiply x, y and z, to **scale coordinates** - not units.

NOTE The z-axis of the local engineering coordinate system is always parallel to the z-axis of the map coordinate system.

NOTE The *Scale* can be used when the length unit for the 3 axes of the map coordinate system are not identical with the length unit established for this project (see *IfcProject.UnitsInContext*) - for example to convert feet into metres. If omitted, the scale factor 1.0 is assumed.

HISTORY New entity in IFC4

8.18.3.6.2 Entity inheritance



8.18.3.6.3 Attributes

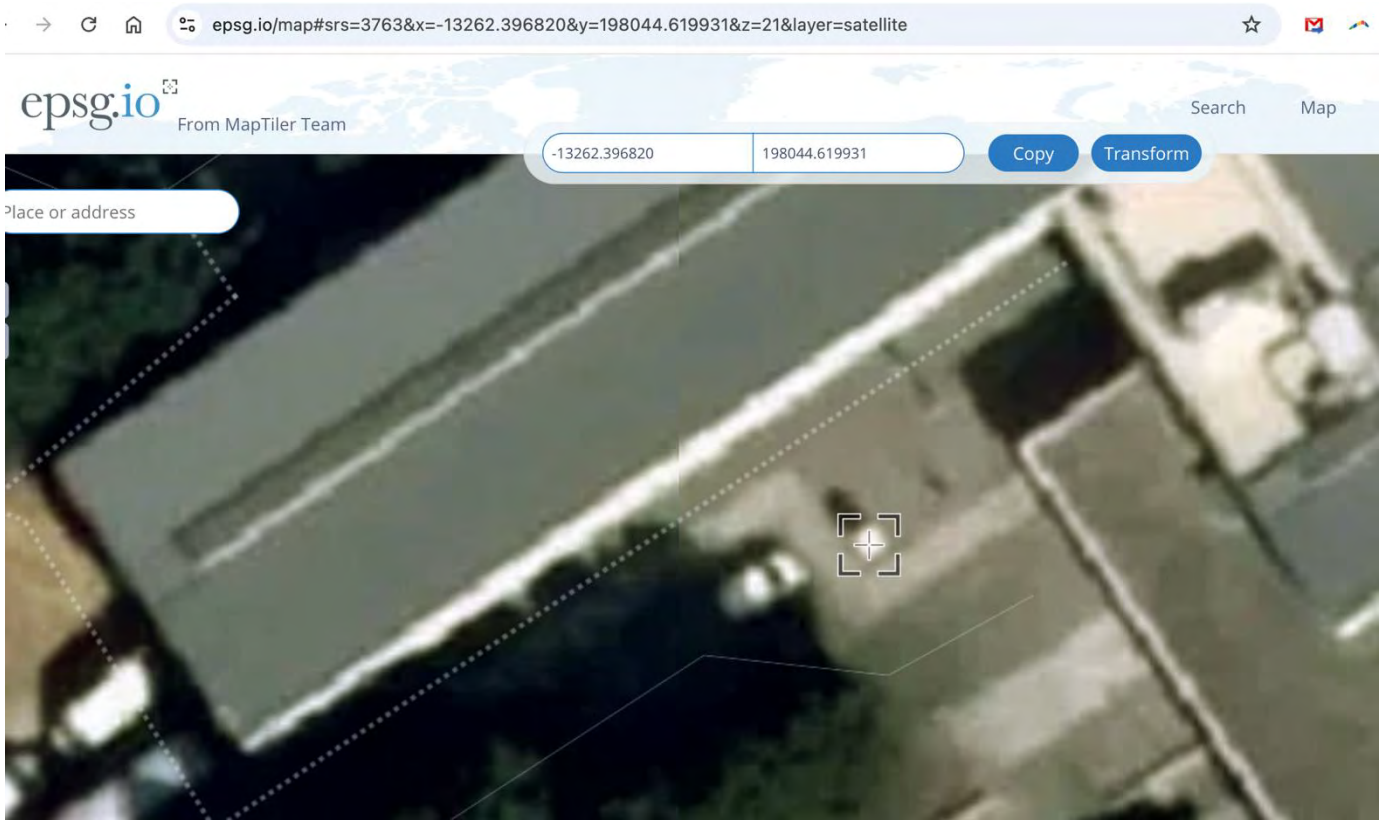
#	Attribute	Type	Description
IfcCoordinateOperation (2)			
			Click to show 2 hidden inherited attributes
IfcMapConversion (6)			
3	Eastings	IfcLengthMeasure	Specifies the location along the easting of the coordinate system of the target map coordinate reference system. NOTE for right-handed Cartesian coordinate systems this would establish the location along the x axis.
4	Northings	IfcLengthMeasure	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
5	OrthogonalHeight	IfcLengthMeasure	Orthogonal height relative to the vertical datum specified. NOTE for right-handed Cartesian coordinate systems this would establish the location along the z axis
6	XAxisAbscissa	OPTIONAL IfcReal	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 NOTE together with the *XAxisOrdinate* it provides the direction of the local x axis within the horizontal plane of the map coordinate system
7	XAxisOrdinate	OPTIONAL IfcReal	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 *XAxisAbscissa* it provides the direction of the local x axis within the horizontal plane of the map coordinate system.
8	Scale	OPTIONAL IfcReal	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.

Preparing the data for the Azurém Campus of the University of Minho (zero in the entry frame)

https://epsg.io/map#srs=3763&x=-13262.396820&y=198044.619931&z=17&layer=satellite

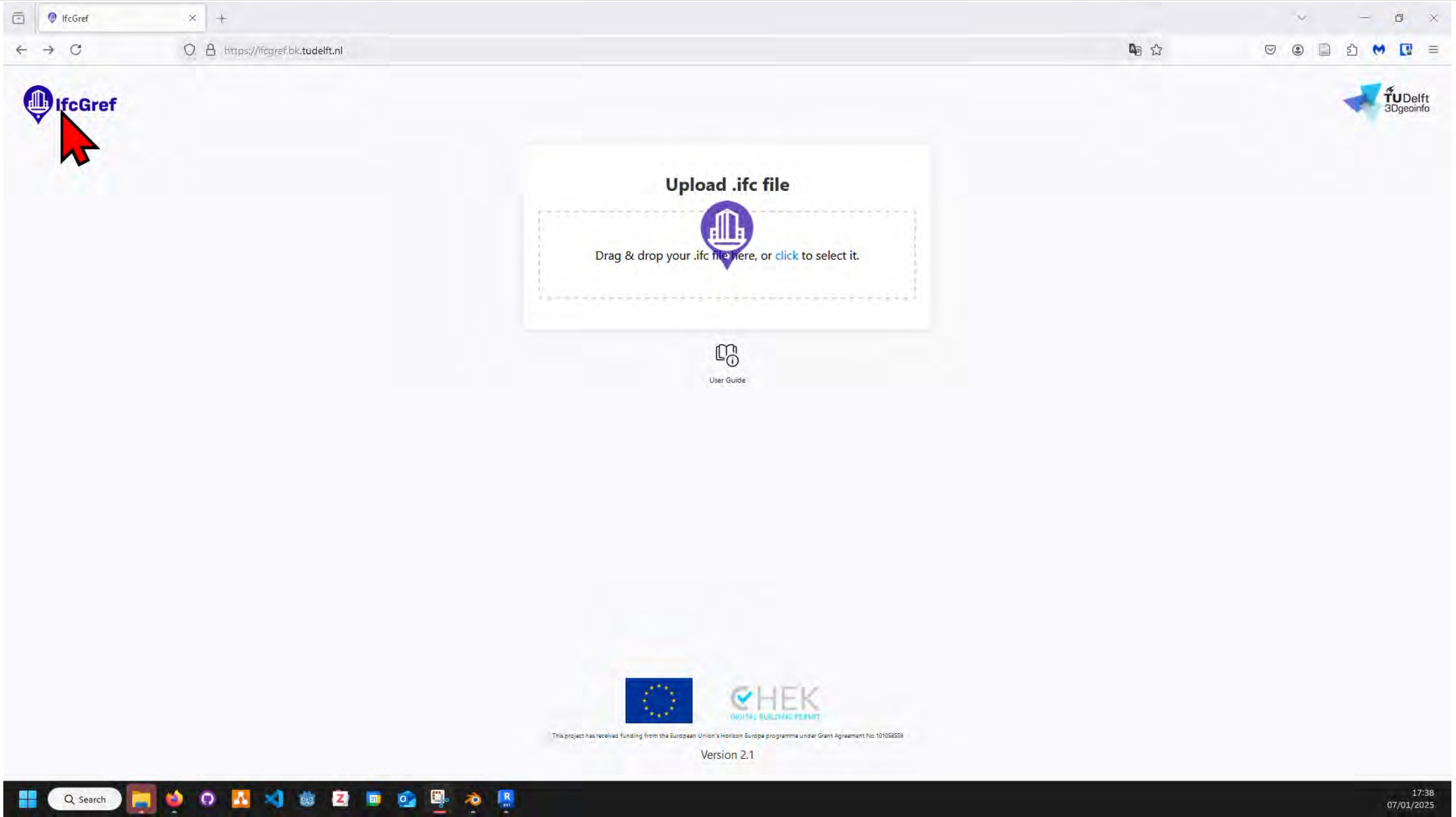
13262.3960, -- 3 - Easting
198044.6199, -- 4 - Northing
190.0, -- 4 - OrthHeight
1.0, -- 5 - XAxisAbscissa (rotação no X)
0.0, -- 6 - XAxisOrdinate (rotação no Y)
1.0 -- 7 - Scale

#	Attribute
	IfcCoordinateOperation
	IfcMapConversion (6)
3	Eastings
4	Northings
5	OrthogonalHeight
6	XAxisAbscissa
7	XAxisOrdinate
8	Scale



Recognising correct georeferencing in an IFC

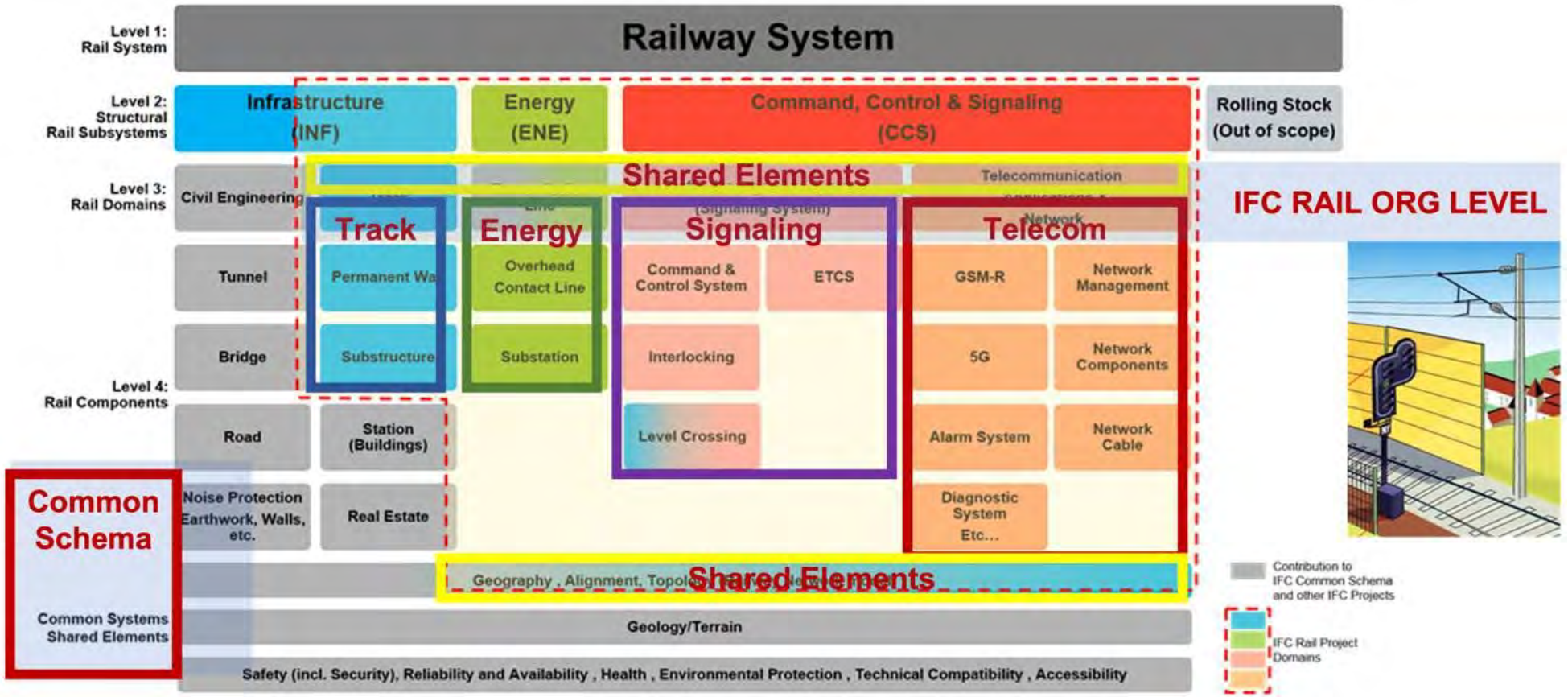
www.chekdbp.eu



Application of IFC in the context of infrastructures

IFC





Application of IFC in the context of infrastructures

IFC 4.3.2.20240904 (IFC4X3_ADD2) under development

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5 Core data schemas
6 Shared element data schemas
7 Domain specific data schemas

7.8.3.1 IfcRail

NOTE This entity is a subtype of IfcProduct or IfcTypeProduct and hence part of every standardized schema subset and implementation level.

7.8.3.1.1 Semantic definition

A rail is a predominately linear built element that has a special section profile. Rail is distinctive from built elements with similar geometric shapes (e.g. beam, member) that its major function is to ensure guidance of moving for vehicles or other kinds of machineries.

7.8.3.1.2 Entity inheritance

7.8.3.1.3 Attributes

7.8.3.1.4 Formal propositions

7.8.3.1.5 Property sets

Pset_Condition	Pset_ConstructionAdministration	Pset_ConstructionOccurence
AssessmentDate	ProcurementMethod	InstallationDate
AssessmentCondition	SpecificationSectionNumber	ModelNumber
Pset_ElementKinematics	Pset_EnvironmentalCondition	Pset_EnvironmentalImpactIndicators
CyclicPath	ReferenceAirRelativeHumidity	Reference
CyclicRange	ReferenceEnvironmentTemperature	FunctionalUnitReference
Pset_EnvironmentalImpactValues	Pset_InstallationOccurrence	Pset_MaintenanceStrategy
TotalPrimaryEnergyConsumption	InstallationDate	AssetCriticality
WaterConsumption	AcceptanceDate	AssetFrailty

6.4.4.10.3 Properties

Name	Property Type	Data Type	Description
AssetCriticality	IfcPropertyEnumeratedValue	PEnum_AssetRating	Rating of the asset's criticality to the operation of the facility
AssetFrailty	IfcPropertyEnumeratedValue	PEnum_AssetRating	Rating of the asset's frailty to breakage or deterioration
AssetPriority	IfcPropertyEnumeratedValue	PEnum_AssetRating	Combined criticality and frailty rating indicating the operational and maintenance priority of the asset
MonitoringType	IfcPropertyEnumeratedValue	PEnum_MonitoringType	Monitoring strategy chosen for the asset
AccidentResponse	IfcPropertyEnumeratedValue	PEnum_AccidentResponse	Accident response chosen for the asset

IFC

Application of IFC in the context of infrastructures

IFC 4.3.2.20240904 (IFC4X3_ADD2) under development

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7.9.3.3 IfcRoad

NOTE This entity is a subtype of IfcProduct or IfcTypeProduct and hence part of every standardized schema subset and implementation level.

7.9.3.3.1 Semantic definition

A route built on land to allow travel from one location to another, including highways, streets, cycle and foot paths, but excluding railways. As a type of Facility, Road provides the basic element in the project structure hierarchy for the components of a road project (i.e. any undertaking such as design, construction or maintenance).

NOTE Definition from ISO 6707-1: Way mainly for vehicles.

NOTE Definition from PIARC: Line of communication (travelled way) using a stabilized base other than rails or air strips, primarily for the use of road motor vehicles running on their own wheel.

7.9.3.3.2 Entity inheritance

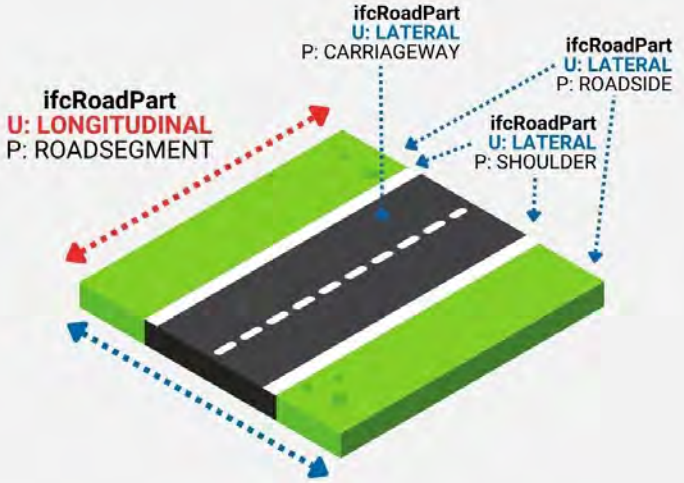
7.9.3.3.3 Attributes

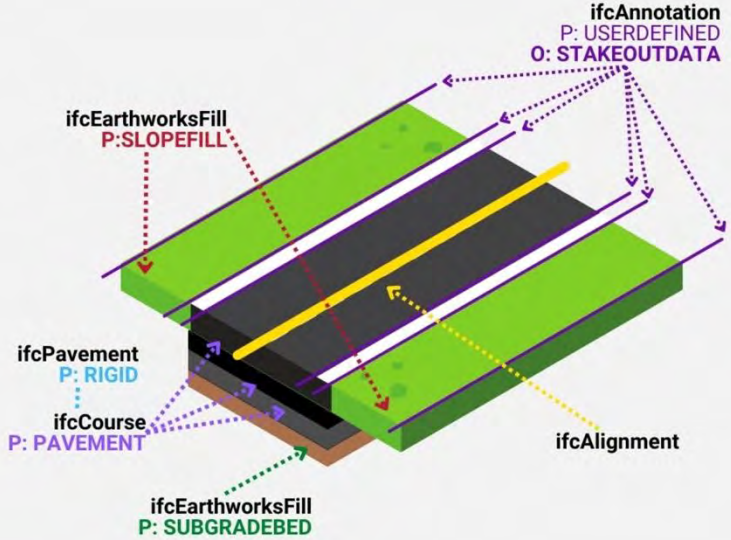
7.9.3.3.4 Formal propositions

7.9.3.3.5 Property sets

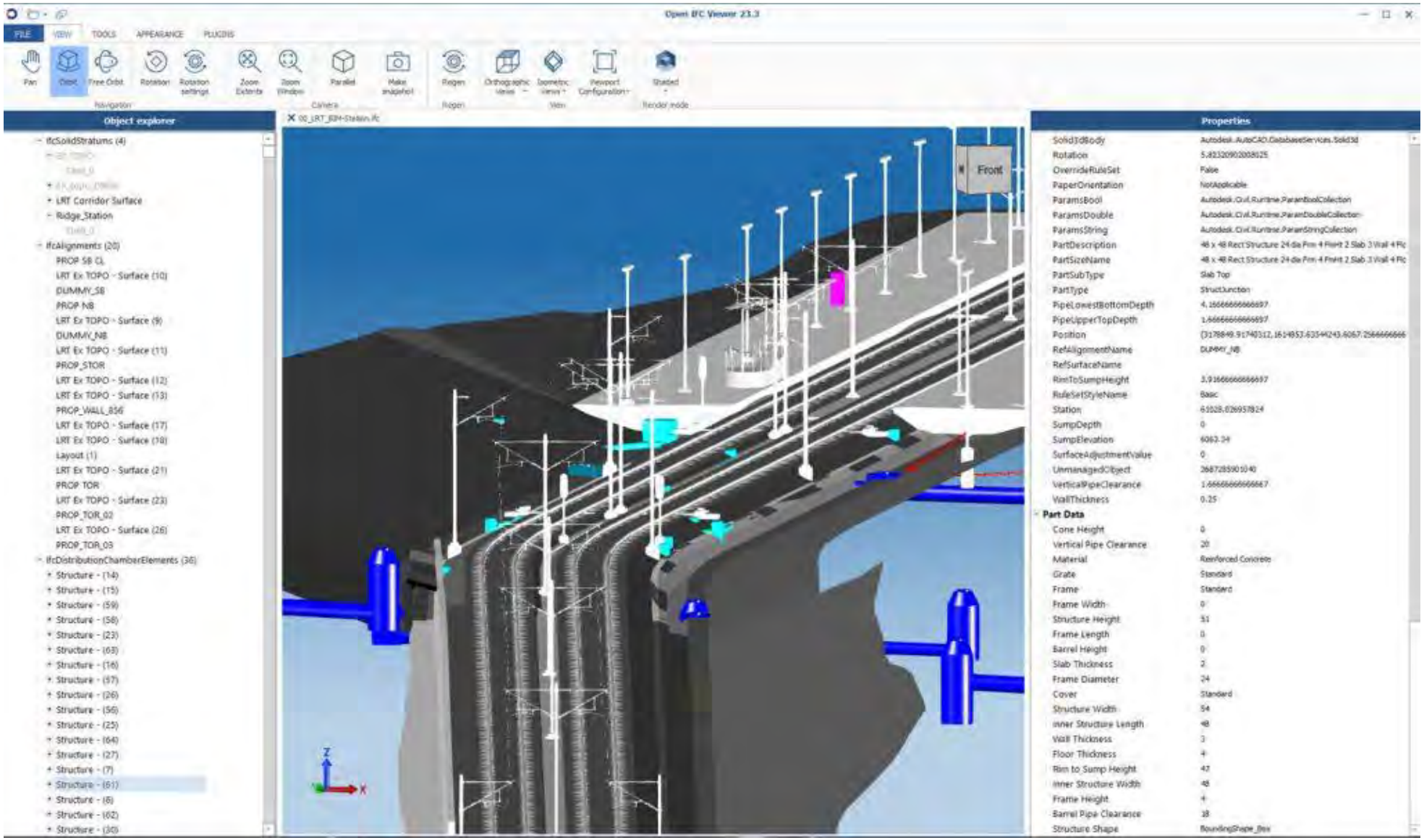
Pset_AirSideSystemInformation	Pset_PropertyAgreement	Pset_Risk
Description	AgreementType	RiskName
AirSideSystemType	TrackingIdentifier	RiskType
AirSideSystemDistributionType	AgreementVersion	NatureOfRisk

Pset_RoadDesignCriteriaCommon	Pset_SpaceAirHandlingDimensioning	Pset_SpaceCommon





Application of IFC in the context of infrastructures



The importance of Type and Predefined Type

4.1.3.2 Object Predefined Type

Many object occurrences have an attribute named *PredefinedType* being a specific enumeration. Such predefined type essentially provides another level of "classification by inheritance" to further differentiate objects without the need for additional sub types. Predefined types are not just informational; various rules apply such as applicable property sets, part composition, and distribution ports. Such predefined types are added by selecting the correct enumerator for the attribute *PredefinedType*. If a custom value is needed, the attribute *ObjectType* has to be used to define such custom type, whereas the *PredefinedType* is set to *USERDEFINED*.

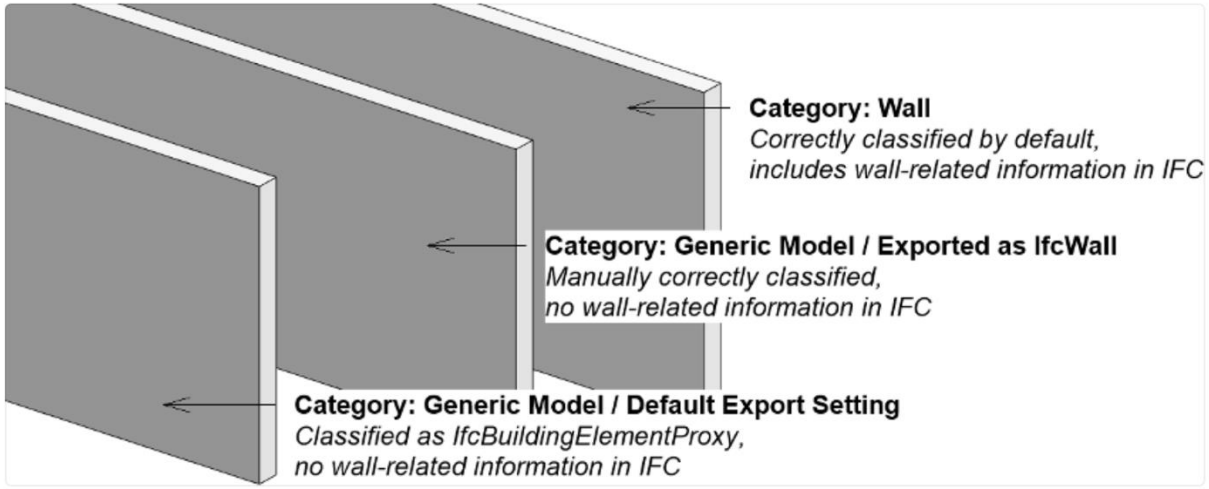
The main attributes to be provided for an *Object Occurrence Predefined Type* are:

— *PredefinedType*: holds the entity specific enumeration of predefined types to further classify the entity
— *ObjectType*: allows for a custom value, if no applicable enumerator can be found

If the object is typed by an *IfcTypeObject*, then the *PredefinedType* at the *IfcObject* occurrence shall only be used if the *PredefinedType* at *IfcTypeObject* is set to *NOTDEFINED*.

Note that the PredefinedType attribute itself is defined at the leaf classes of the inheritance hierarchy with a specific enumeration attribute for that given leaf class.

The following diagram shows the generic classes and relationships used when applying this concept. In addition, concepts may have particular importance to common or standardised industry practices and scenarios. For these specific usage scenarios, the table below shows a recommended list of general usage patterns that users may adopt.



Autodesk IFC Manual (online)

4.3.4 Object Predefined Type

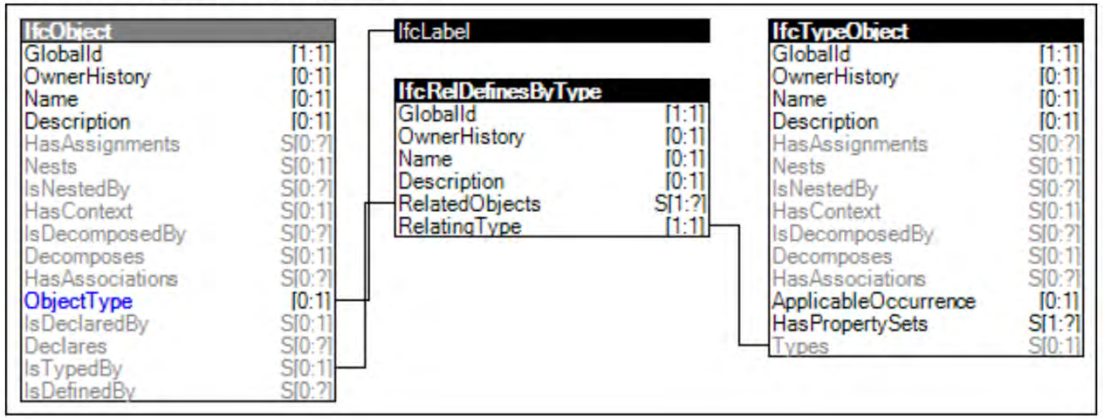
Many object occurrences have an attribute named *PredefinedType* being a specific enumeration. Such predefined type essentially provides another level of "classification by inheritance" to further differentiate objects without the need for additional sub types. Predefined types are not just informational; various rules apply such as applicable property sets, part composition, and distribution ports.Such predefined types are added by selecting the correct enumerator for the attribute *PredefinedType*. If a custom value is needed, the attribute *ObjectType* has to be used to define such custom type, whereas the *PredefinedType* is set to *USERDEFINED*.

The main attributes to be provided for a *Object Occurrence Predefined Type* are:

- *PredefinedType*: holds the entity specific enumeration of predefined types to further classify the entity
- *ObjectType*: allows for a custom value, if no applicable enumerator can be found

If the object is typed by an IfcTypeObject, then the *PredefinedType* at the IfcObject occurrence shall only be used if the *PredefinedType* at IfcTypeObject is set to *NOTDEFINED*.

Figure 18 illustrates an instance diagram.



IFC file formats

For the widest compatibility and smallest size for file-based import and export, STEP Physical File (SPF) is recommended. For web service communication, any of the above formats may be automatically negotiated by clients and servers.

Format	Extension	MIME Type	Text	Indexed	Size	Summary
Official						
STEP Physical File (SPF)	.ifc	application/x-step	Yes	No	100%	STEP Physical Format (SPF or IFC-SPF) is the most widely used format for IFC in practice, which is the most compact of the formats listed that can be read as text. IFC-SPF is based on the ISO standard for clear text representation of EXPRESS data models ISO 10303-21
Extensible Markup Language (XML)	.ifcXML	application/xml	Yes	No	113%	Extensible Markup Language (XML) provides enhanced readability and benefits from a broad range of software tools. ifcXML is based on the ISO standard for representation of STEP data in XML format ISO 10303-28
ZIP	.ifcZIP	application/zip	No	No	17%	IFC data may embedded within a ZIP file. The embedded data may be encoded as either SPF or XML, where the resulting size is typically comparable.

https://technical.buildingsmart.org/standards/ifc/ifc-formats/

There are more formats such as RDF, JSON, HDF, SQLite... (not widely used)

Ifc file structure in STP

The ".ifc" file is a STEP physical file, SPF, and thereby a structured ASCII text file. The basic SPF structure divides each file into a header and a data section. The header section has information about:

- the IFC version used
- the application that exported the file
- the date and time when the export was done
- (often optionally) the name, company and authorizing person of the file

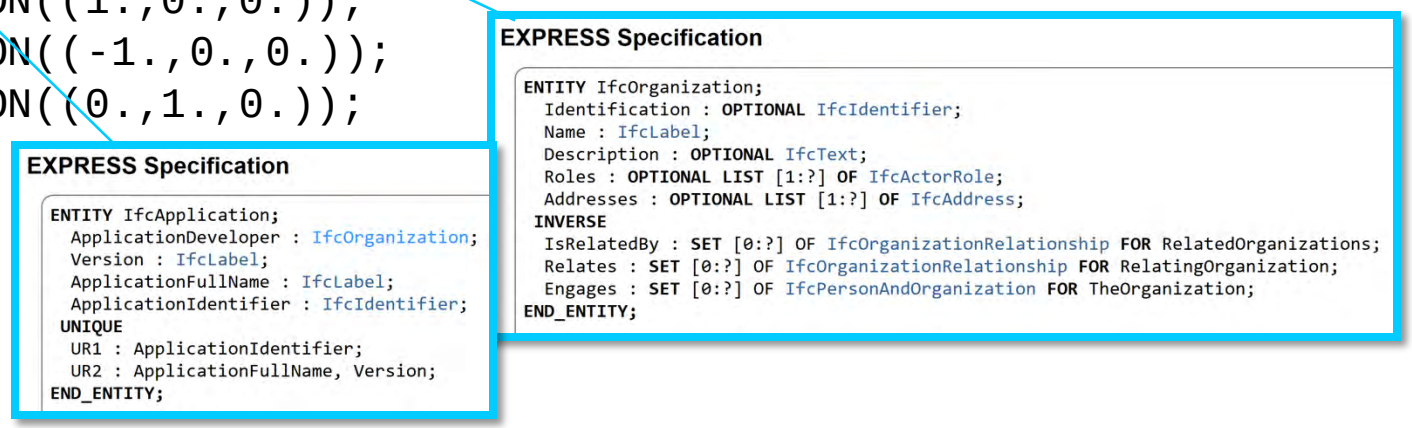
```
FILE_DESCRIPTION(('ViewDefinition [CoordinationView_V2.0]'),'2;1');
FILE_NAME('11-478A','2017-10-25T15:18:08',(''),(''),
        'The EXPRESS Data Manager Version 5.02.0100.07 : 28 Aug 2013',
        '20170630_0700(x64) - Exporter 18.2.0.0 - Alternate UI
18.2.0.0','');
FILE_SCHEMA(('IFC2X3'));
ENDSEC;
```

(Liebich, 2009)

Ifc file structure in STP

The data section contains all instances for the entities of the IFC specification. These instances have a unique (within the scope of a file) STEP Id, the entity type name and a list of explicit attribute.

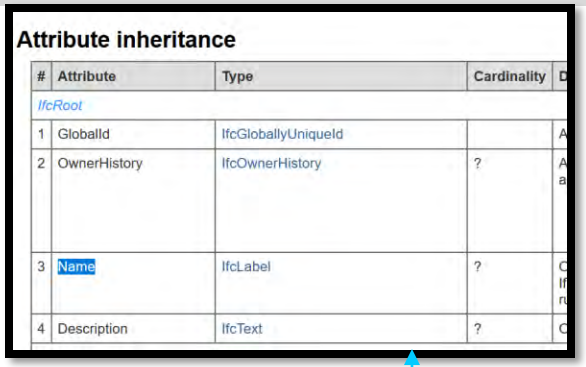
```
DATA;
#1= IFCORGANIZATION($,'Autodesk Revit 2018 (ENU)',$,$,$);
#5= IFCAPPLICATION(#1,'2018','Autodesk Revit 2018 (ENU)','Revit');
#6= IFCCARTESIANPOINT((0.,0.,0.));
#9= IFCCARTESIANPOINT((0.,0.));
#11= IFCDIRECTION((1.,0.,0.));
#13= IFCDIRECTION((-1.,0.,0.));
#15= IFCDIRECTION((0.,1.,0.));
(…)
```



The STEP Id is only valid for a single exchange, if the same user project is exported a second time, these Id's will change. The order of the instances within the data section is not significant.

(Liebich, 2009)

Ifc file structure in STP



Attribute inheritance

#	Attribute	Type	Cardinality
IfcRoot			
1	GlobalId	IfcGloballyUniqueId	
2	OwnerHistory	IfcOwnerHistory	?
3	Name	IfcLabel	?
4	Description	IfcText	?

Known by clicking in attribute inherhitance in IfcWallStandardCase and following #'s

```
(...)
#35= IFCPERSON($,'','anni',$,$,$,$,$);
#37= IFCORGANIZATION($,'','',$,$);
#38= IFCPERSONANDORGANIZATION(#35,#37,$);
#41= IFCOWNERHISTORY(#38,#5,$,.NOCHANGE.,$,$,$,0);
(...)
#4706= IFCLOCALPLACEMENT(#122,#4705);
(...)
#4711= IFCSHAPEREPRESENTATION(#100,'Axis','Curve2D',(#4709));
(...)
#4722= IFCSHAPEREPRESENTATION(#102,'Body','SweptSolid',(#4718));
#4724= IFCPRODUCTDEFINITIONSHAPE($,$,(#4711,#4722));
(...)
#4726= IFCWALLSTANDARDCASE('3a3WlvDYb6DAFWHotokJbU',      -> GlobalId (IfcRoot)
                           #41,                           -> OwnerHistory (IfcRoot)
                           'Basic Wall:V02a:2197024',     -> Name (IfcRoot)
                           $,                             -> Description (IfcRoot)
                           'Basic Wall:V02a:2705732',     -> ObjectType (IfcObject)
                           #4706,                         -> ObjectPlacement (IfcProduct)
                           #4724,                         -> Representation (IfcProduct)
                           '2197024');                    -> Tag (IfcElement)
(...)
ENDSEC;
```

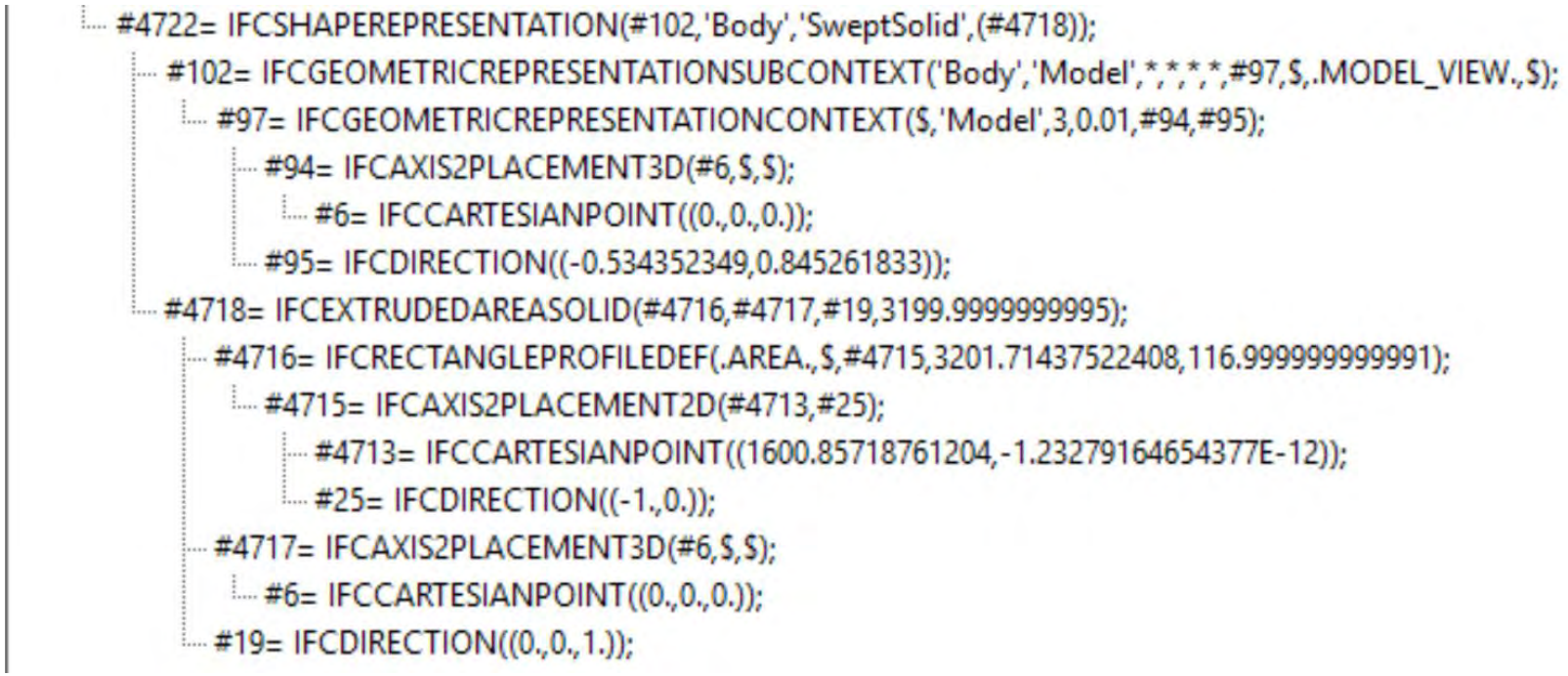
Tree structure of #4726 (part 1/2)


```
#4726= IFCWALLSTANDARDCASE('3a3WlvDYb6DAFWHotokJbU',#41,'Basic Wall:V02a:2197024',$,'Basic Wall:V02a:2705732',#4706,#4724,'2197024');
  #41= IFCOWNERHISTORY(#38,#5,$,.NOCHANGE.,$,$,$,0);
    #38= IFCPERSONANDORGANIZATION(#35,#37,$);
      #35= IFCPERSON($,'','anni',$,$,$,$,$);
      #37= IFCORGANIZATION($,'','',$,$);
    #5= IFCAPPLICATION(#1,'2018','Autodesk Revit 2018 (ENU)','Revit');
      #1= IFCORGANIZATION($,'Autodesk Revit 2018 (ENU)',$,$,$);
  #4706= IFCLOCALPLACEMENT(#122,#4705);
    #122= IFCLOCALPLACEMENT(#32,#121);
      #32= IFCLOCALPLACEMENT(#588611,#31);
        #588611= IFCLOCALPLACEMENT($,#588610);
          #588610= IFCAXIS2PLACEMENT3D(#588608,$,$);
            #588608= IFCCARTESIANPOINT((152677777.,6555555555.,148200.));
        #31= IFCAXIS2PLACEMENT3D(#6,$,$);
      #121= IFCAXIS2PLACEMENT3D(#6,$,$);
        #6= IFCCARTESIANPOINT((0.,0.,0.));
    #4705= IFCAXIS2PLACEMENT3D(#4701,#19,#4703);
      #4701= IFCCARTESIANPOINT((82065.54492832,56587.1345854737,0.));
      #19= IFCDIRECTION((0.,0.,1.));
      #4703= IFCDIRECTION((-0.942981279601907,0.332845769569556,0.));
  #4724= IFCPRODUCTDEFINITIONSHAPE($,$,(#4711,#4722));
    #4711= IFCSHAPEREPRESENTATION(#100,'Axis','Curve2D',(#4709));
      #100= IFCGEOMETRICREPRESENTATIONSUBCONTEXT('Axis','Model',*,*,*,*,#97,$,.GRAPH_VIEW.,$);
        #97= IFCGEOMETRICREPRESENTATIONCONTEXT($,'Model',3,0.01,#94,#95);
          #94= IFCAXIS2PLACEMENT3D(#6,$,$);
            #6= IFCCARTESIANPOINT((0.,0.,0.));
          #95= IFCDIRECTION((-0.534352349,0.845261833));
      #4709= IFCPOLYLINE((#9,#4707));
        #9= IFCCARTESIANPOINT((0.,0.));
        #4707= IFCCARTESIANPOINT((3201.71437522408,0.));
    #4722= IFCSHAPEREPRESENTATION(#102,'Body','SweptSolid',(#4718));
```

GEM TEAM SOLUTIONS

IfcQuickBrowser

Tree structure of #4726 (part 2/2)

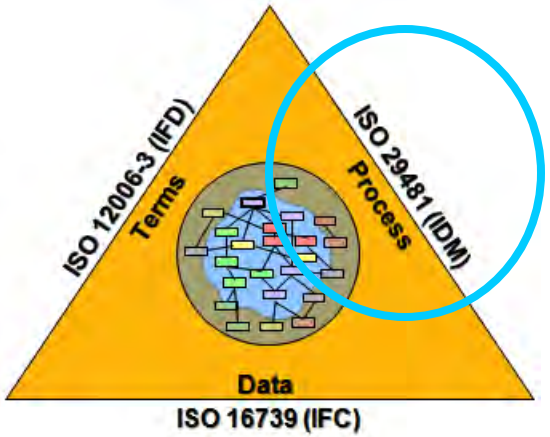


An example of Ifc file examined in a viewer

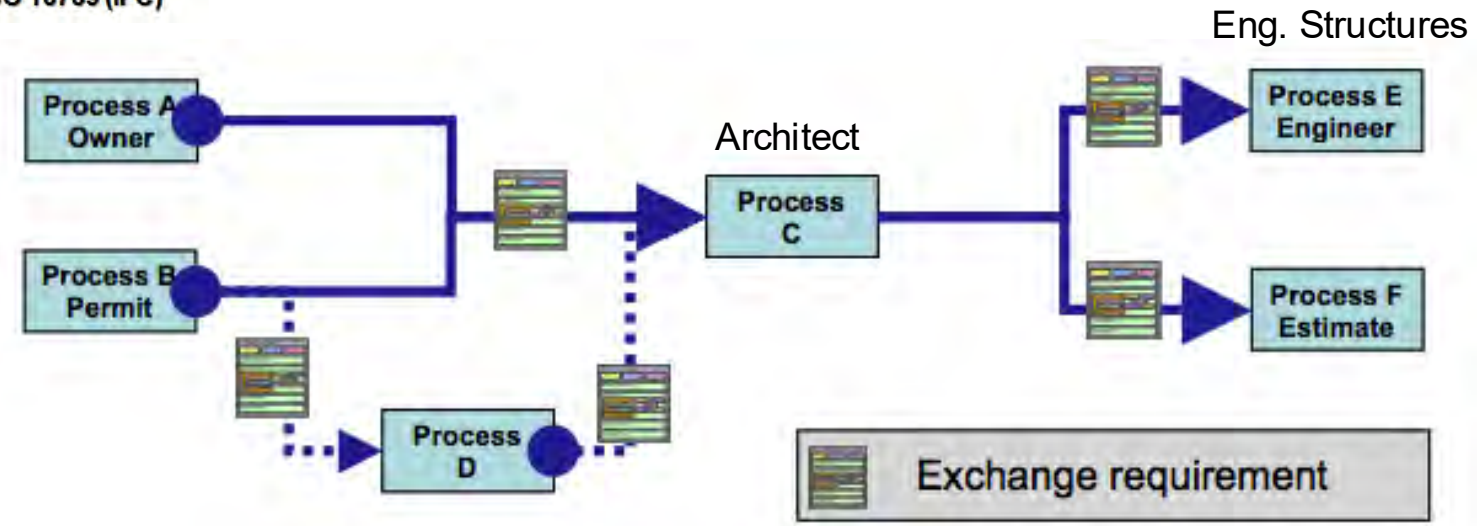
Let’s see an example


IDM/MVD

The relevance of information processes and exchanges: MVD and IDM (1/2)



- Great diversity of actors throughout the life cycle of the design, construction and use of the building;
- The various actors can exchange information in IFC format throughout the process;
- A set of 'contracted exchanges' of information can be imagined, with often only part of the information in the model needing to 'circulate' to the next actor.

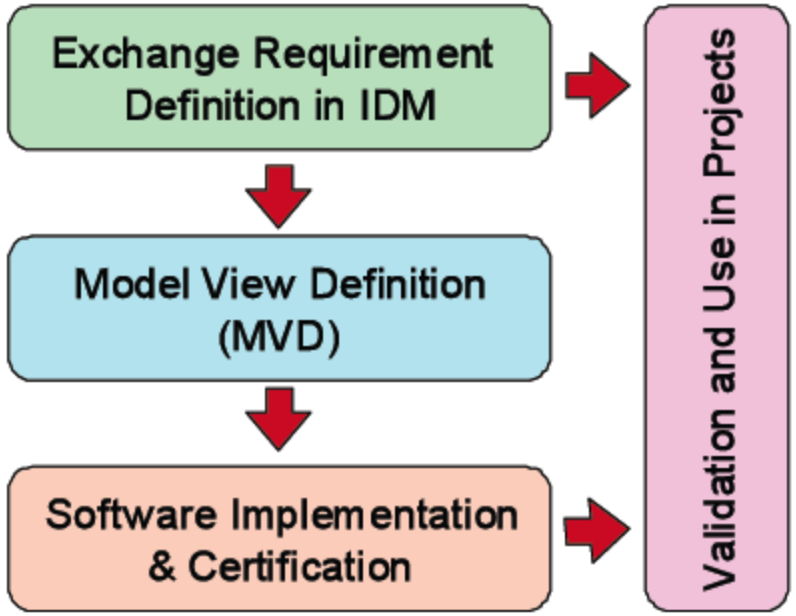


Need for specific definition of information to be exchanged and classifications

The relevance of information processes and exchanges: MVD and IDM (2/2)

- The definition of how the ‘exchange of contracted information’ is defined in a document called the Information Delivery Manual (IDM), defined by the BIM users (AEC actors);

- From the IDM it is possible to define the software implementation of the data sets that have to be exchanged: Model View Definition (MVD), and in turn the software implementation process is carried out and the desirable IFC interoperability is made available to the end user.



Model View Definition (MVD)

- MVD defines a subset of the SCHEMA IFC that is needed to fulfil one or more Exchange Requirements in the context of the AEC industry (IDM-ERM-MVD link);

- The MVD therefore defines a set of information relating to the IFC concepts (classes, attributes, relationships, property sets, quantities, etc) to be used within the subset represented with that MVD. -> therefore represents the software requirements for implementing IFC interfaces that fulfil the ‘information exchange requirements’;

- While IDM and ERM are independent of the IFC version in force, MVD is specific to each version.

Important impacts of MVD on interoperability

- Minimises information exchanges to the strictly fundamental, paving the way for the automation of information exchanges;

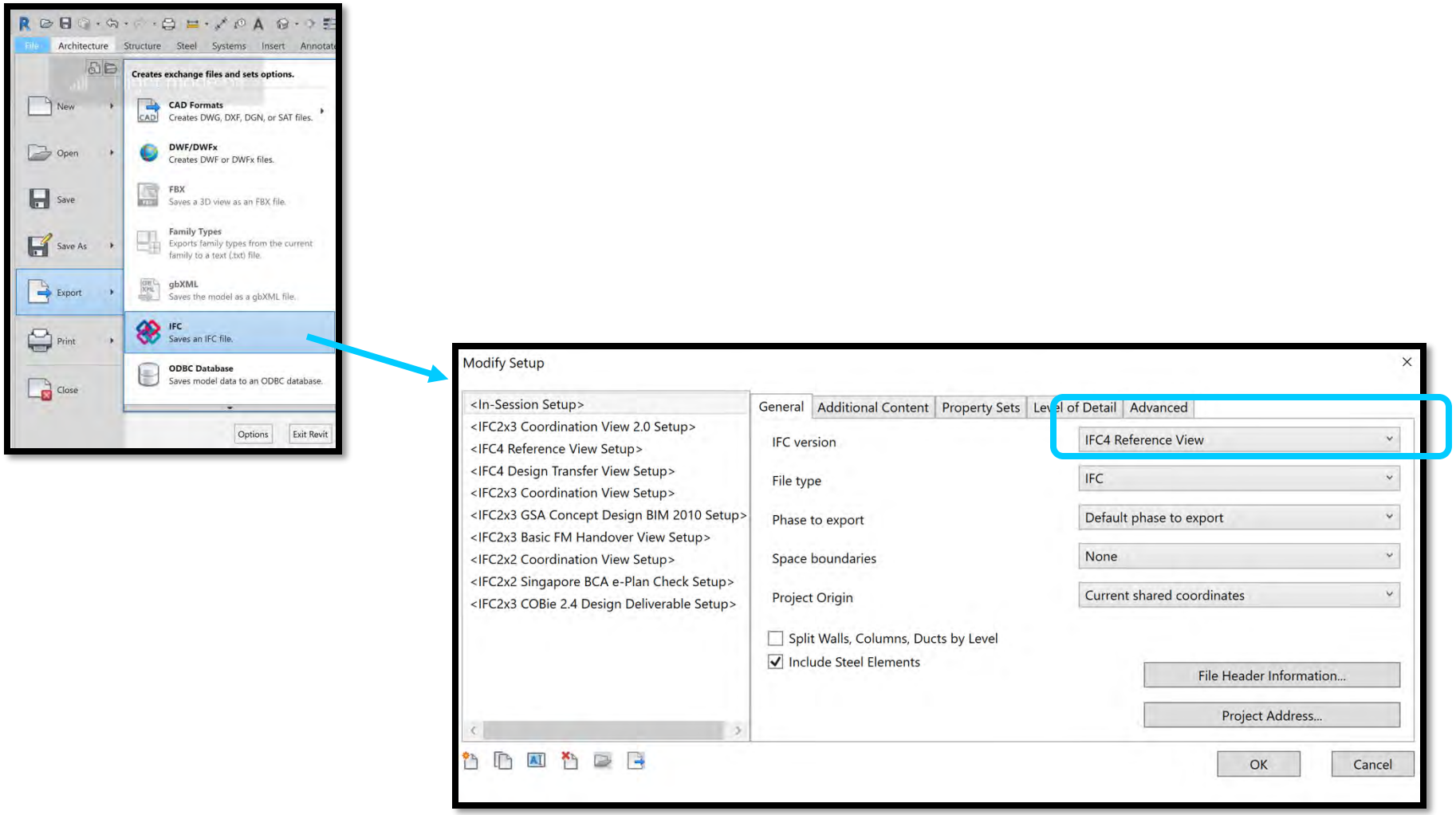
- Real possibilities for defining MVDs for regulatory verification and licensing.

Examples of MVD

- Examples of MVDs include:
- *Architectural Design to Structural Design* - where the architect is providing the structural engineer a model "background" that can be referenced for the placement and design of structural elements.
- *Architectural Design to Quantity Takeoff* - where the architect is providing the general contractor a model that has accurate element placement extents for extracting quantities and assigning cost figures.
- *Building Envelope Design to Energy Analysis* - where an architect or building envelope designer/engineer provides the energy consultant a model with specific construction types and material thermal values, as well as thermal comfort values for internal spaces to determine building performance.
- *Construction Operations Building Information Exchange (COBie)* - where a contractor provides as-built data to the owner and facility manager for operations.

https://technical.buildingsmart.org/standards/mvd/

How MVD's are used in practice



Currently available MVD's by buildingSMART

IFC Schema	MVD Name	Status	Documentation	Summary
IFC4 ADD2 TC1	IFC4Precast	Final	Full documentation (zip)	Exchange of geometric information between CAD and MES systems for automated production of precast building components.
IFC4.2	Bridge Construction View	Draft	BRie 2017.10.24	Build and maintain bridges.
IFC4 ADD2 TC1	Reference View	Final	RV 1.2 HTML RV_1-2_mvdxml	Simplified geometric and relational representation of spatial and physical components to reference model information for design coordination between architectural, structural, and building services (MEP) domains
IFC4 ADD2 TC1	Design Transfer View	Draft	DTV 1.1	Advanced geometric and relational representation of spatial and physical components to enable the transfer of model information from one tool to another. Not a "round-trip" transfer, but a higher fidelity one-way transfer of data and responsibility.
IFC4 ADD2 TC1	Quantity Takeoff View	Draft	mvdXML	Estimate and track construction materials and costs.
IFC4 ADD2 TC1	Energy Analysis View	Draft	EV	Estimate and track energy usage and costs.
IFC4 ADD2 TC1	Product Library View	Draft	LV 0.1	Manufacturer product information and configurations.
IFC4	LandXML view		LandXML MVD 1.2	Basic buildingSMART MVD for LandXML v1.2.
IFC2x3 TC1	Coordination View	Final	CV 2.0	Spatial and physical components for design coordination between architectural, structural, and building services (MEP) domains
				Identification and export of additional Space Boundaries (polygons which define

https://technical.buildingsmart.org/standards/ifc/mvd/mvd-database/

IFC4 MVD – Reference View and Design Transfer View

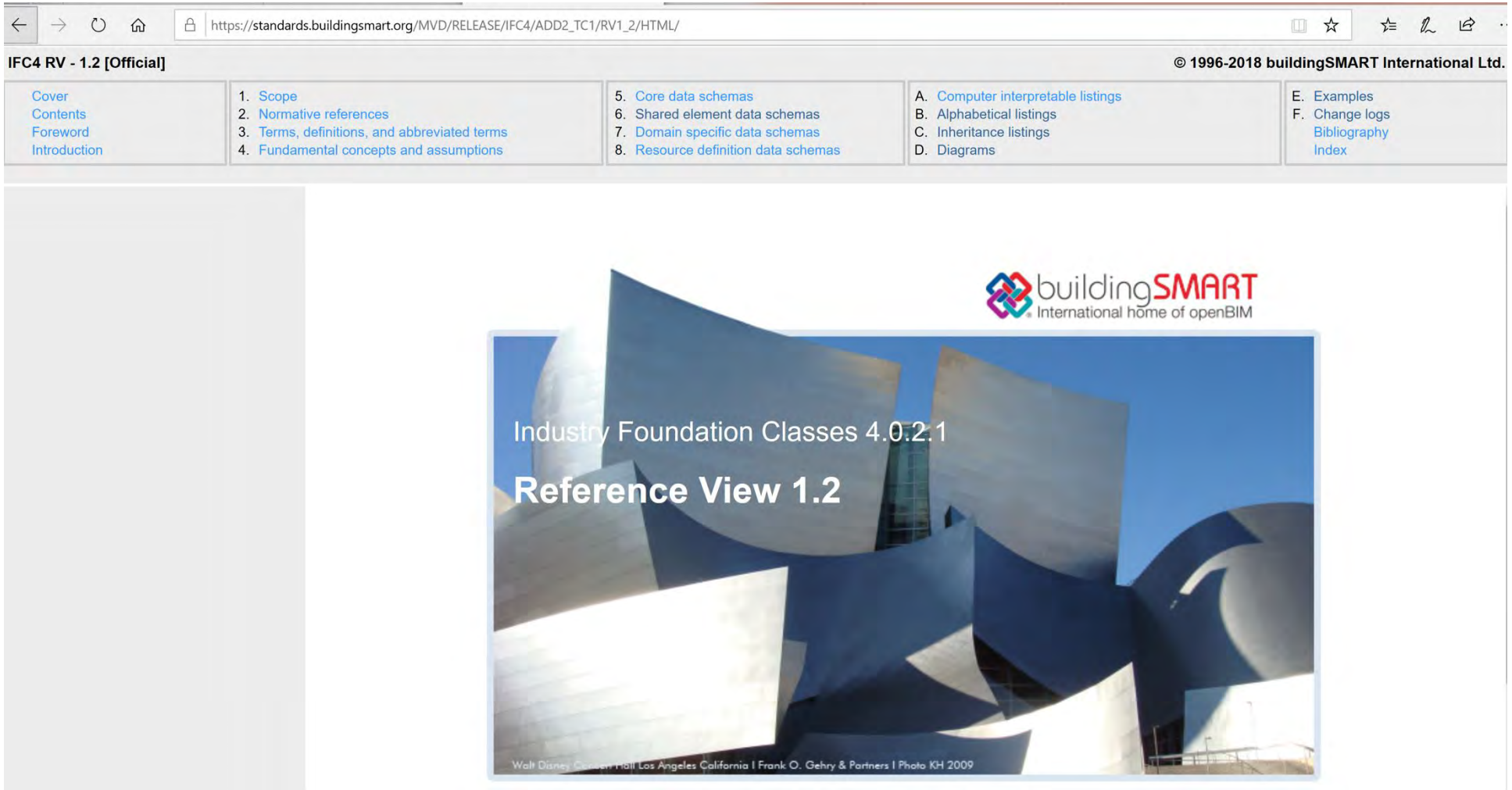
Reference View
Purpose: Support the coordination of the planning disciplines architecture, structural analysis and building service. Especially support clash detection and resolution of issues resulting from geometry. This can be understood as a CV2.0 with slightly reduced and more focused range.

Design Transfer View
Purpose: Support the transfer of model data to be used for further design, analysis, estimating and facility management tasks. This can be understood as a CV2.0 with some extended range.

Note: CV 2.0 was a MVD used in the scope if IFC 2x3 TC1

IFC Schema	MVD Name	Status	Documentation	mvdXML	Summary
IFC2x3 TC1	Coordination View	Official	CV 2.0	N/A	Spatial and physical components for design coordination between architectural, structural, and building services (MEP) domains

Reference view



https://standards.buildingsmart.org/MVD/RELEASE/IFC4/ADD2_TC1/RV1_2/HTML/

Some features of the Reference view

The main purpose of this document is to define a standardized subset of the IFC4 schema, a Model View Definition MVD, that is particularly suitable for all BIM workflows that are based on reference models, where the exchange is mainly one-directional.

Here requested modifications of the BIM data, mainly of the shape representation, are handled by a change request to the original author, and changes are not executed upon the imported IFC data with the intent to be sent back to the original source.

Examples of this reference workflow are:

- Coordination planning (combining different discipline specific IFC models for visual checking)
- Clash detection (finding clashes between different discipline specific IFC models)
- Background reference (loading an IFC model, usually from a different discipline) as a linked model
- Quantity take-off (determine the quantities of the various model elements with the IFC model)
- Construction sequencing (taking the IFC model and associating it to a construction schedule)
- Visual presentation (for presenting the IFC model to a broad audience)

Some features of the Reference view

Common characteristics of the workflow using reference models are:

- The source of the BIM information remains with the originator
- The full parametric behaviour, and thereby the intellectual engineering property, remains with the originator
- The ownership of the model, and responsibility for its correctness, remains with the originator
- The original model is published as IFC4 Reference View model reflecting the as-is status
- The receiver of the IFC4 Reference View model has access to the full model content
- The receiver of the IFC4 Reference View is not supposed to modify the model
- The receiver of the IFC4 Reference View can analyse and extract the information of the model
- If the receiver suggests or demands a change, it has to be communicated as a change request to the originator
- The buildingSMART standard BCF (BIM Collaboration Format) is developed to efficiently support these change requests

The overall goal of the IFC Reference View is to provide workflows where building information models are to be consumed by the widest array of software applications that do not require modifying geometry. Such applications enable viewing, estimating, building, operating, and other downstream analysis.
EXAMPLE One target scenario is an architect providing building design information to a contractor or facility manager. It is expected that the resulting geometry would reflect sufficient realism for viewing in software (dimensions, normals, colors, textures), but not of rendering quality for artistic presentations (lighting, shader effects, curve interpolation, rasterizing).

What is included in the Reference View?

1.1.6 Model elements

The main components of the IFC4 Reference View are the semantic model elements that carry a predefined meaning. The complete breakdown of all model elements declared in IFC4 are also known as the IFC4 built-in classification following an element by function classification.

In addition to each of the model elements shown here in the subsequent tables, each Model element maybe further specialized by its "*PredefinedType*", or even a user defined type.

EXAMPLE An IfcFireSuppressionTerminal is a specific model element, that may be further specialized using its *PredefinedType* enumeration being: a sprinkler, a hose reel, a fire hydrant, or a breeching inlet. If a proper predefined type is not yet included in the specification, a user defined type can be assigned as well.

Architectural model elements

shell and core	finishing	furnishing
IfcBeam	IfcCovering	IfcFurniture
IfcColumn	IfcRailing	IfcSystemFurnitureElement
IfcChimney*	IfcShadingDevice	-
IfcRamp+	IfcCurtainWall	-
IfcStair++	IfcDoor	-
IfcRoof	IfcWindow	-
IfcSlab	-	-
IfcWall	-	-

LEGEND * new in IFC4, + includes IfcRampFlight, ++ includes IfcStairFlight

Structural model elements

Foundation & Frame	Reinforcement	Fastener, etc.
IfcFooting	IfcReinforcingBar	IfcFastener
IfcPile	IfcReinforcingMesh	IfcMechanicalFastener

(…)

IDMs from the database of buildingSMART

IDM Database

buildingSMART International is publishing IDMs in the International Use-Case Management tool (UCM).

The Use-Case Management tool is available on https://ucm.buildingsmart.org/

Heritage IDM Database

This is a database of historic Information Delivery Manuals. The listing is for informational purposes only.

If you want to publish your IDM, please use the Use-Case Management tool at https://ucm.buildingsmart.org/

Show 150 entries Search:

Local IDM ID	IDM Name	Owner	Internal IDM Status	Project Manager	Project Manager Contact
ATC-001	Structural Design to Structural Detailing (ATC-75)	Applied Technology Council, Thomas Liebich	Draft	Thomas McLane	tmclane@atcouncil.org
BAMie	Building Automation Modeling information exchange	USACE ERDC / NIBS	?	Billy Byrum	billybyrum@gmail.com
BIMSie	BIM Service interface exchange	TNO / USACE ERDC / NIBS		Now part of the openCDE APIs initiative.	
BPie	Building Programming information exchange	Statsbygg / USACE ERDC / OBO / NIBS / buildingSMART Norway		Bill East	bill.east@prairieskyconsult
BSA-001	Design to Quantity Takeoff	-	Proposal	-	
BSA-002	Design to Energy Performance Analysis	-	Proposal	-	
BSI-001	Architectural Programming to Architectural Design	-	Draft	-	

https://technical.buildingsmart.org/standards/information-delivery-manual/idm-database/

CHEK

DIGITAL BUILDING PERMIT



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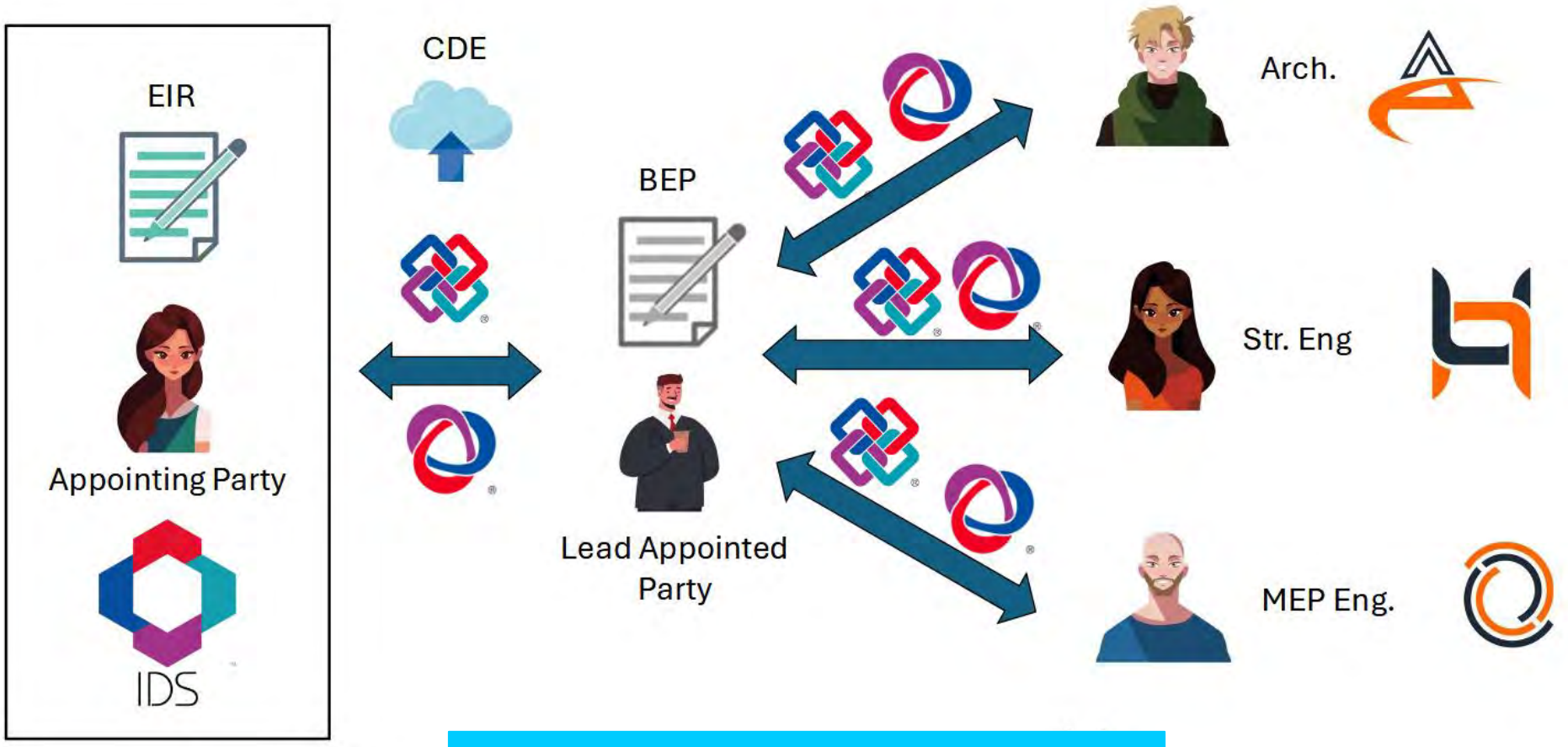
Digital Transformation in Building Permits
Advanced Summer Course

IDS – bSDD – BCF

July 2025

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the European Union

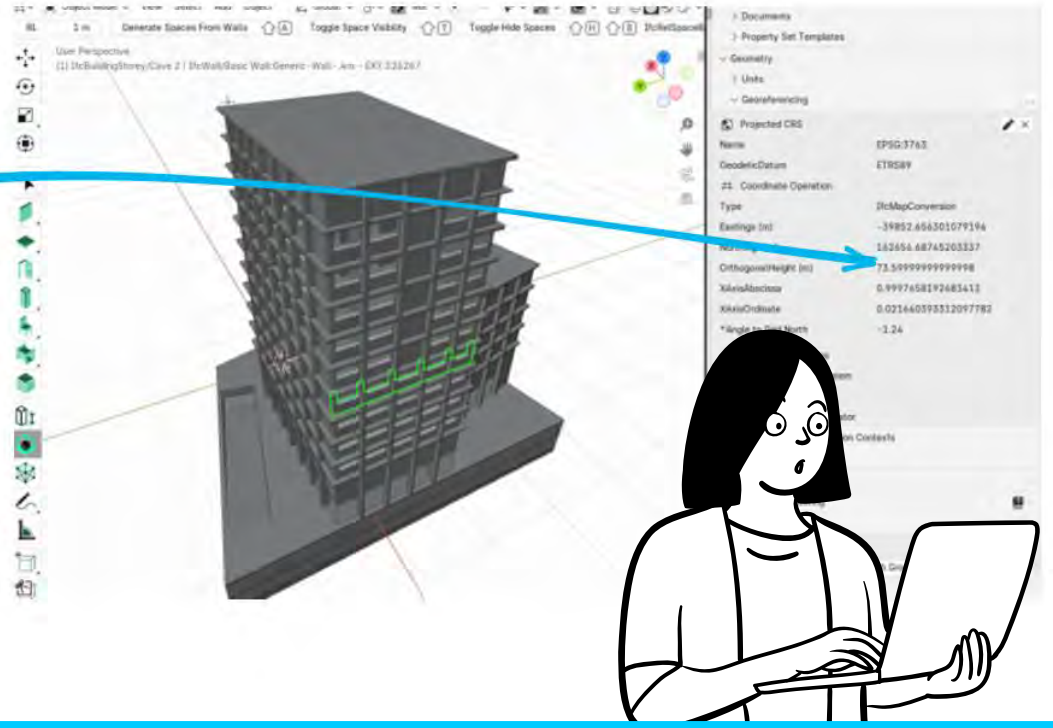
Information Delivery Specification (IDS) - context



Exchange information

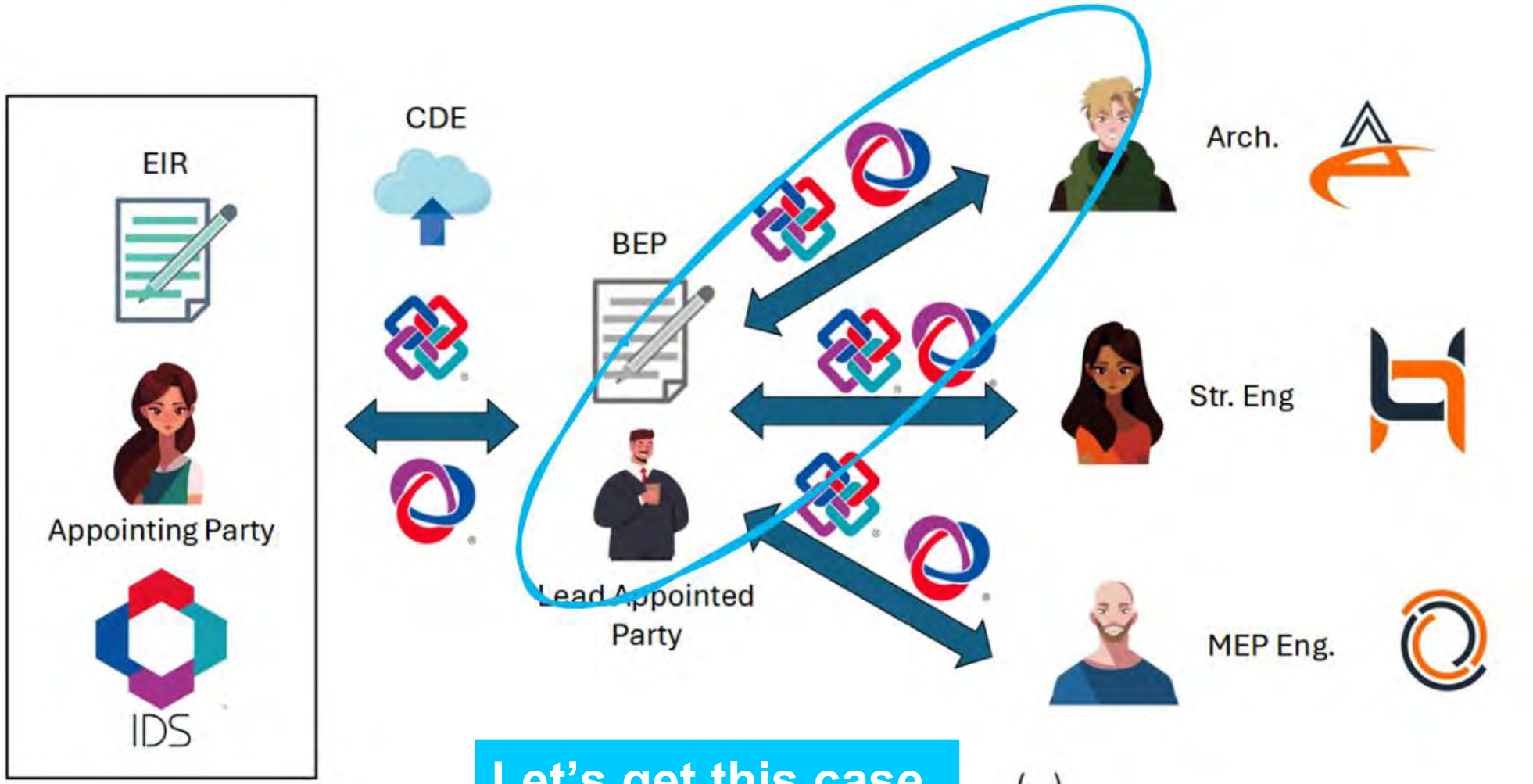
Information Delivery Specification (IDS) - context

1	**Objetos**		*Projeto*	
2	**Ator requerente**		*MMG*	
3	**Ator fornecedor**		*Todos os Projetistas*	
4			**FASE DE PROJETO:**	
5			***Anteprojeto***	***Projeto de Execução***
6	**Proposito**		*EIR 01 a EIR 08*	*EIR 01 a EIR 08*
7	**Requisitos mínimos de informação geométrica**			
8		**Detalhe**	*Não requerido*	*Não requerido*
9		**Dimensão**	*Não requerido*	*Não requerido*
10		**Localização**	*Absoluta*	*Absoluta*
11		**Aparência**	*Não requerido*	*Não requerido*
12		**Comportamento Paramétrico**	*Não requerido*	*Não requerido*
13	**Requisitos mínimos de informação alfanumérica**			
14		*Classe IFC*	*IfcProject*	*IfcProject*
15		**Atributos**		
16			*Name*	X	X
17		**Georeferenciação**		
18			*IfcMapConversion.Eastings*	X	X
19			*IfcMapConversion.Northings*	X	X
20			*IfcMapConversion.OrthogonalHeight*	X	X
21			*IfcMapConversion.XAxisAbscissa*	X	X
22			*IfcMapConversion.XAxisOrdinate*	X	X
23			*IfcProjectedCRS.Name*	X	X
24			*IfcProjectedCRS.GeodeticDatum*	X	X
25			*IfcProjectedCRS.VerticalDatum*	X	X



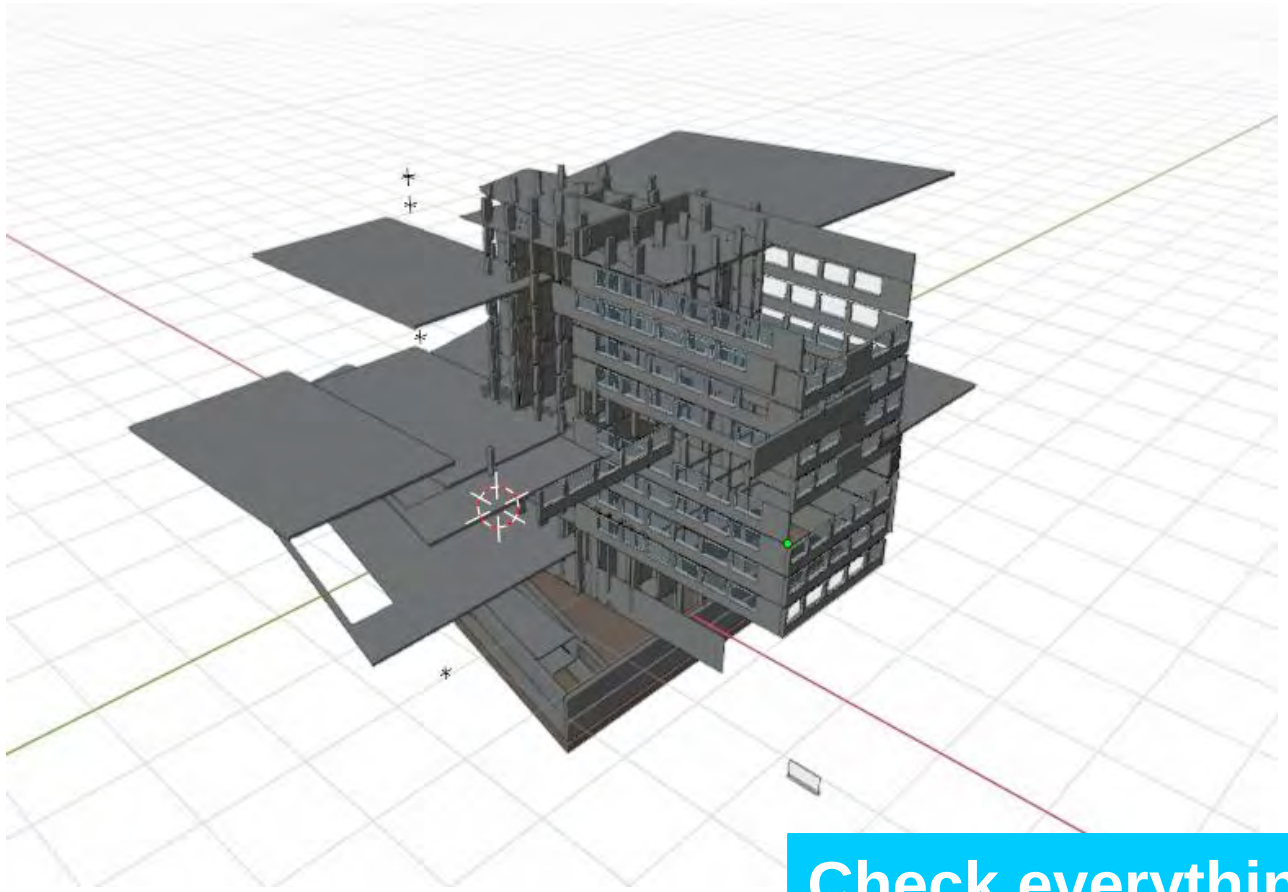
I need to add property A, B, C, D, E, F… And the Object

IDS – What for?



Let's get this case

IDS – What for?







Lacking parameters

Not requested

Check everything manually?

17%

IDS – What for?



The model is not compliant!!

Properties A,B,C,D,E and F are missing

Properties X,Z and Tralala shouldn't be there

The curtain walls are not well classified

...

...

...

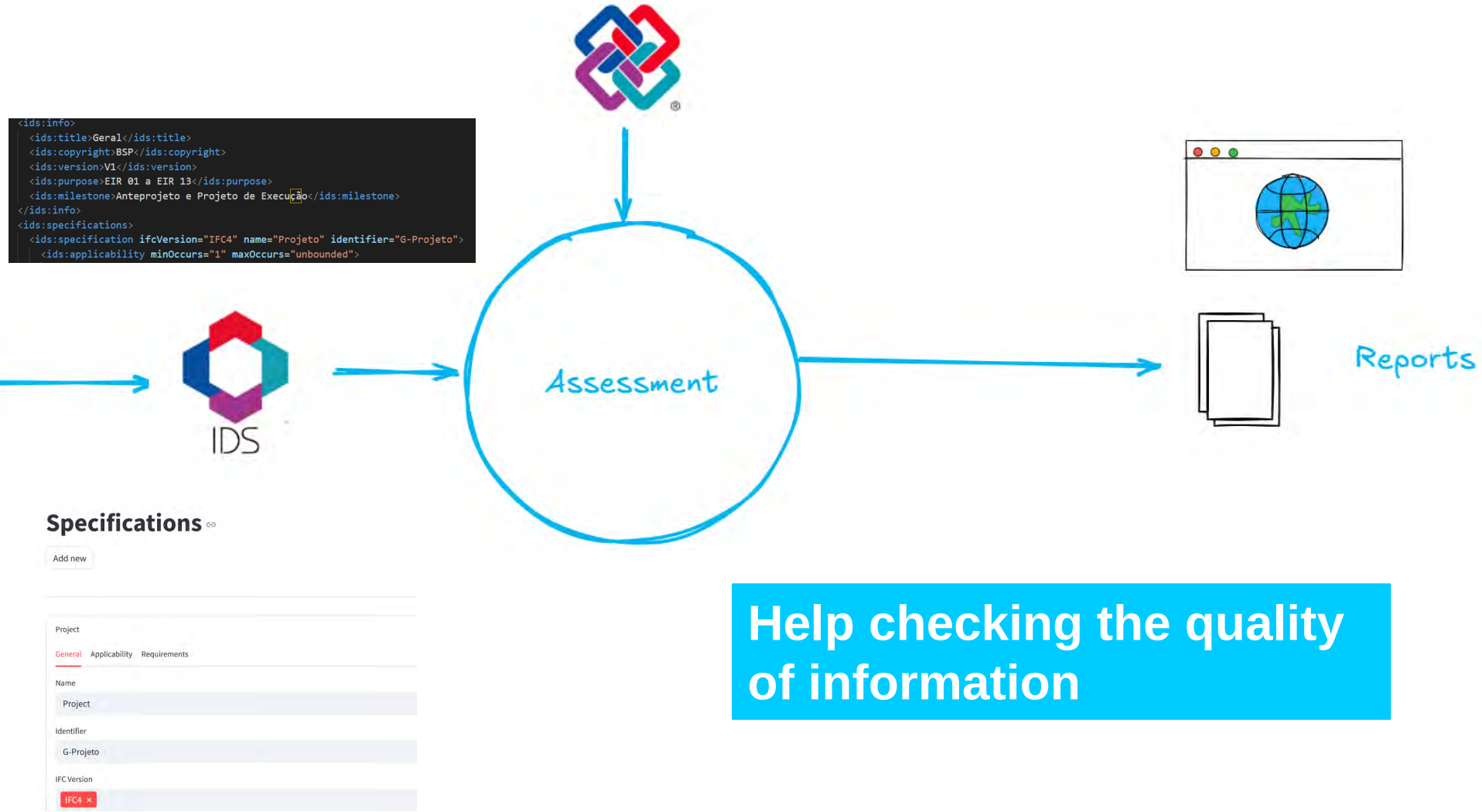
...

...



Should we put this in an email?!

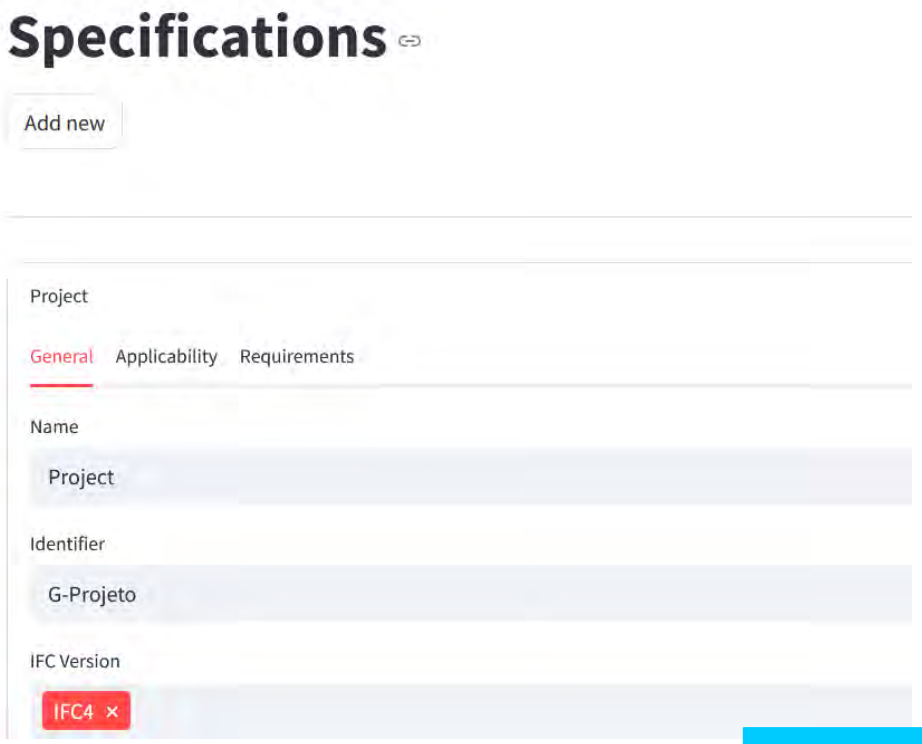
IDS – What for?




```
<ids:info>
  <ids:title>Geral</ids:title>
  <ids:copyright>BSP</ids:copyright>
  <ids:version>V1</ids:version>
  <ids:purpose>EIR 01 a EIR 13</ids:purpose>
  <ids:milestone>Anteprojeto e Projeto de Execução</ids:milestone>
</ids:info>
<ids:specifications>
  <ids:specification ifcVersion="IFC4" name="Projeto" identifier="G-Projeto">
    <ids:applicability minOccurs="1" maxOccurs="unbounded">
```

Help checking the quality of information

IDS – What for?




```
<ids:info>
  <ids:title>Geral</ids:title>
  <ids:copyright>BSP</ids:copyright>
  <ids:version>V1</ids:version>
  <ids:purpose>EIR 01 a EIR 13</ids:purpose>
  <ids:milestone>Anteprojeto e Projeto de Execução</ids:milestone>
</ids:info>
<ids:specifications>
  <ids:specification ifcVersion="IFC4" name="Projeto" identifier="G-Projeto">
    <ids:applicability minOccurs="1" maxOccurs="unbounded">
```

Can be easily created!

IDS – What for?



Georeferenciação Map Conversion

100%

Pass Checks passed: **5 / 5** Elements passed: **1 / 1**

Applicability

- All IFCMAPCONVERSION data

Requirements

1. The Eastings shall be provided
2. The Northings shall be provided
3. The OrthogonalHeight shall be provided
4. The XAxisAbscissa shall be provided
5. The XAxisOrdinate shall be provided

Lote

100%

Pass Checks passed: **2 / 2** Elements passed: **2 / 2**

Applicability

- All IFCSITE data

Requirements

1. The Name shall be provided

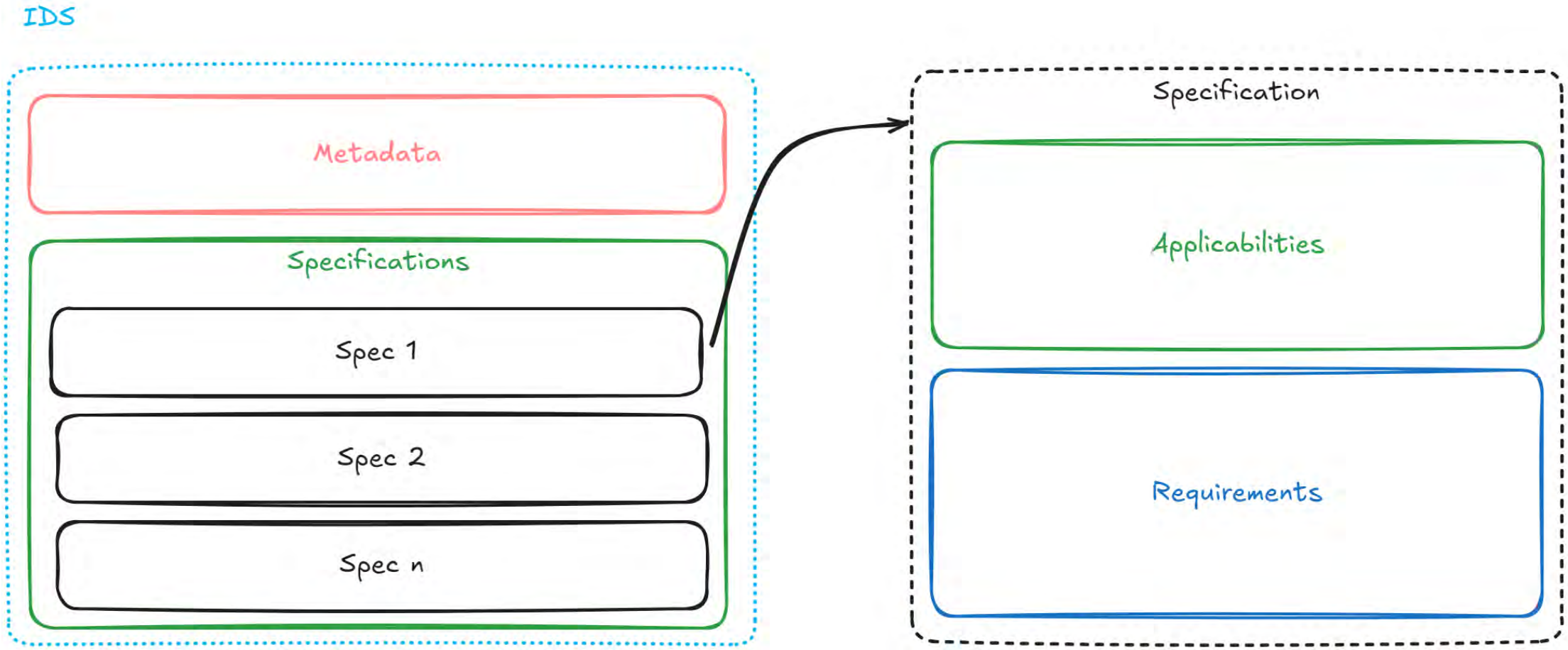
Edificio

Applicability

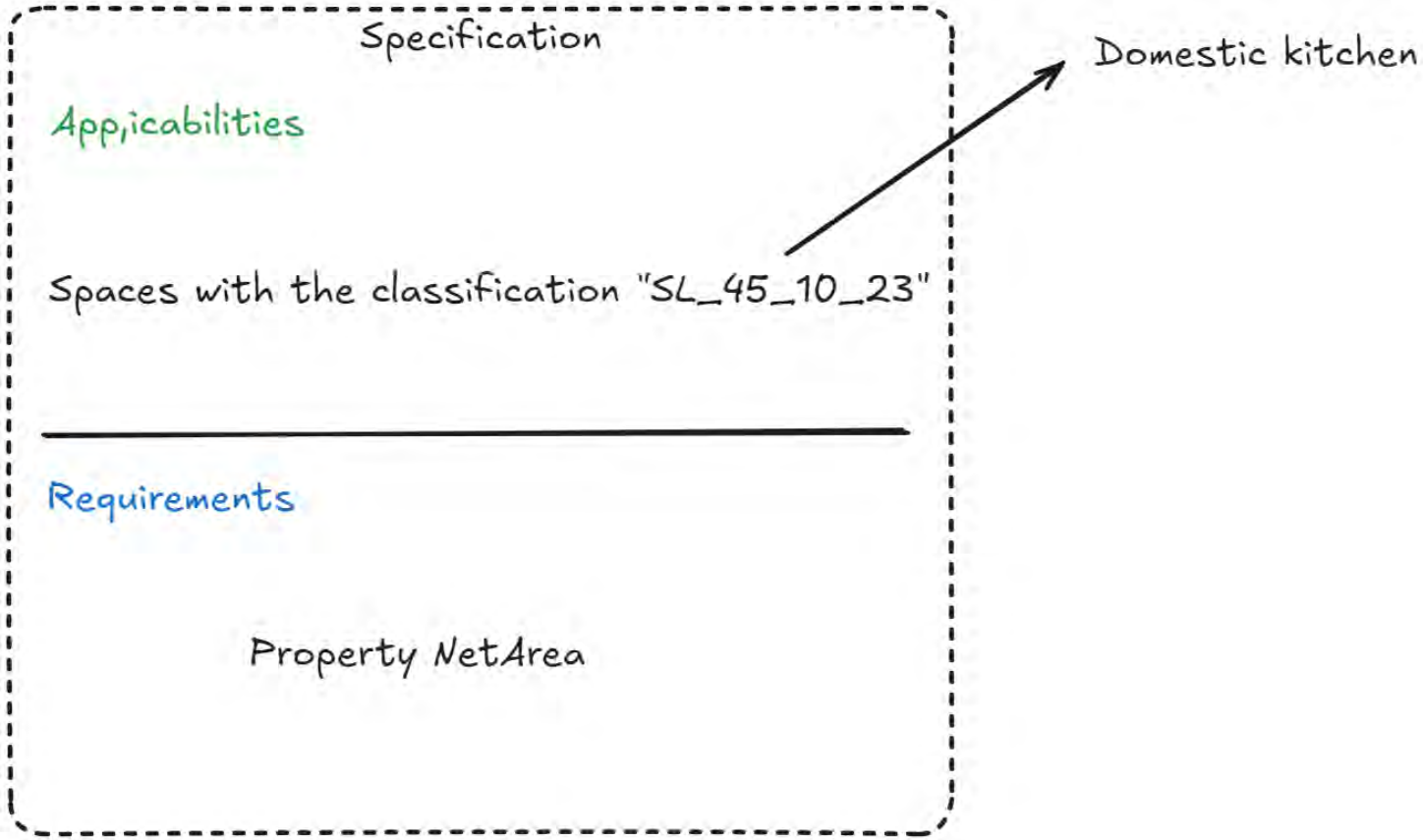


Easily verifiable and precise!

IDS - Structure



IDS - Structure



IDS - Documentation

Let's briefly check the docs

Information Delivery Specification



Information Delivery Specification (IDS) is a buildingSMART standard for specifying and checking simple information requirements from IFC models. It is designed as a free, lightweight, standardised approach to model checking. Read more on the official website.

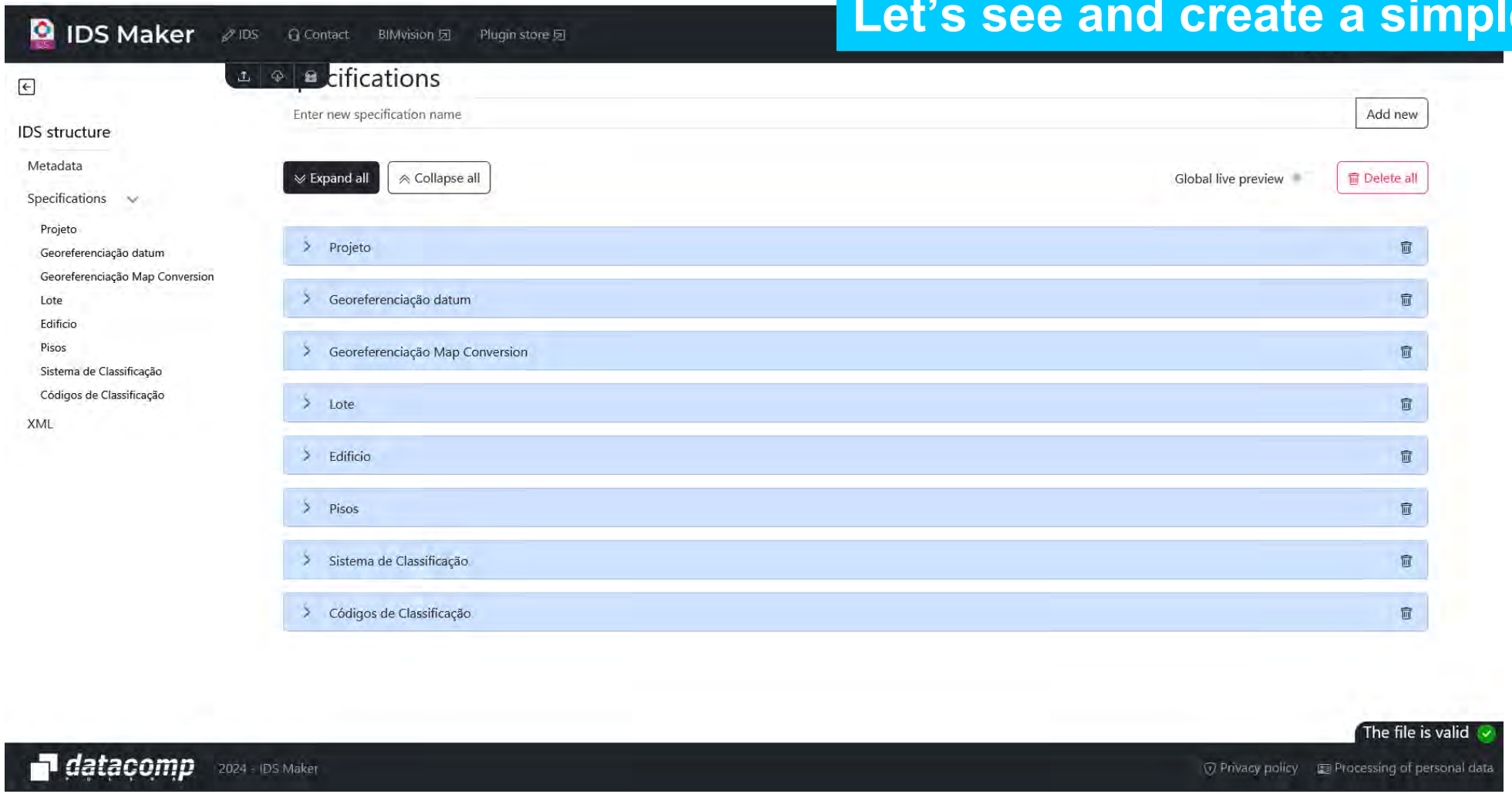
Introduction

An IDS is a file format ending in `.ids` containing a list of information **Specifications**. For example, a single **Specification** might say that "*all walls must have a fire rating property*". Model authors receiving an IDS file can use it to ensure all required information is provided for each **Specification**. Model recipients may use the IDS file to check whether the IFC model meets all of the **Specifications**. Reports may also be

https://github.com/buildingSMART/IDS/tree/development/Documentation/UserManual

IDS – Exploring and creating one

Let's see and create a simple IDS



Practical case

Specification 1: all the spaces must have the attribute PredefinedType with one of the following values:
→ (GFA;NOTDEFINED;USERDEFINED;PARKING;SPACE;IMPLANTACAO;LOTE);

Specification 2: all the spaces with the Predefined Type of GFA must have a property “Uso” within the Property set “PtLicenciamento” with one of the following values:
→ (Enumeration:Habitação;Serviços;Comercio;Estacionamento;)



https://ids.bimvision.eu

5.4.3.45 IfcSpace

What's a space in IFC?

5.4.3.45.1 Semantic definitions at the entity

Entity definition

A space represents an area or volume bounded actually or theoretically. Spaces are areas or volumes that provide for certain functions within a building.

5.4.2.11.1 Semantic definitions at the type

Type definition

This enumeration defines the available generic types for IfcSpace and IfcSpaceType.

HISTORY New enumeration in IFC2x3.

IFC4 CHANGE The enumerators INTERNAL and EXTERNAL have been added for upward compatibility to replace *InteriorOrExteriorSpace* usage.

Enumeration definition

Constant	Description
SPACE	Any space not falling into another category.
PARKING	A space dedication for use as a parking spot for vehicles, including access, such as a parking aisle.
GFA	Gross Floor Area - a specific kind of space for each building story that includes all net area and construction area (also the external envelop). Provision of such a specific space is often required by regulations.
INTERNAL	
EXTERNAL	
USERDEFINED	
NOTDEFINED	

buildingSmart Data Dictionaries (bSDD)

IFC

SPACE
PARKING
GFA
INTERNAL
EXTERNAL
USERDEFINED
NOTDEFINED

Regulation - RGEU

	number of rooms per dwelling							
	2 T0	3 T1	4 T2	5 T3	6 T4	7 T5	8 T6	more than 8 Tx > 6
	areas in square meters							
Master bedroom.....	---	10,5	10,5	10,5	10,5	10,5	10,5	10,5
Double bedroom.....	---	---	9	9	9	9	9	
Double bedroom.....	---	---	---	9	9	9	9	
Double bedroom.....	---	---	---	---	---	9	9	remaining rooms 9m²
Single bedroom.....	---	---	---	---	6,5	6,5	6,5	6,5
Single bedroom.....	---	---	---	---	---	---	6,5	6,5
Living room.....	10	10	12	12	12	16	16	16
Kitchen.....	6	6	6	6	6	6	6	6
Obligatory area supplement.....	6	4	6	8	8	8	10	(x+4)m² (x= number of rooms)

How IFC connects to other domains?

When IFC gives you freedom, ~~make 5348972482 custom properties~~ **try to use a data dictionary**

67%

buildingSmart Data Dictionaries (bSDD)

Terms & Definitions

data dictionary

centralized repository of information about data such as meaning, relationships to other data, origin, usage and format

Note 1 to entry: The definition is from IBM Dictionary of Computing[15].

ISO 23386:2020(en), 3.9

Available in: EN FR

https://www.iso.org/obp

What is bSDD?

About Content Purpose

bSDD

bSDD is a collection of interconnected data dictionaries with definitions of terms to describe the built environment. The service is provided by buildingSMART for free, to enable easy access from all software solutions.

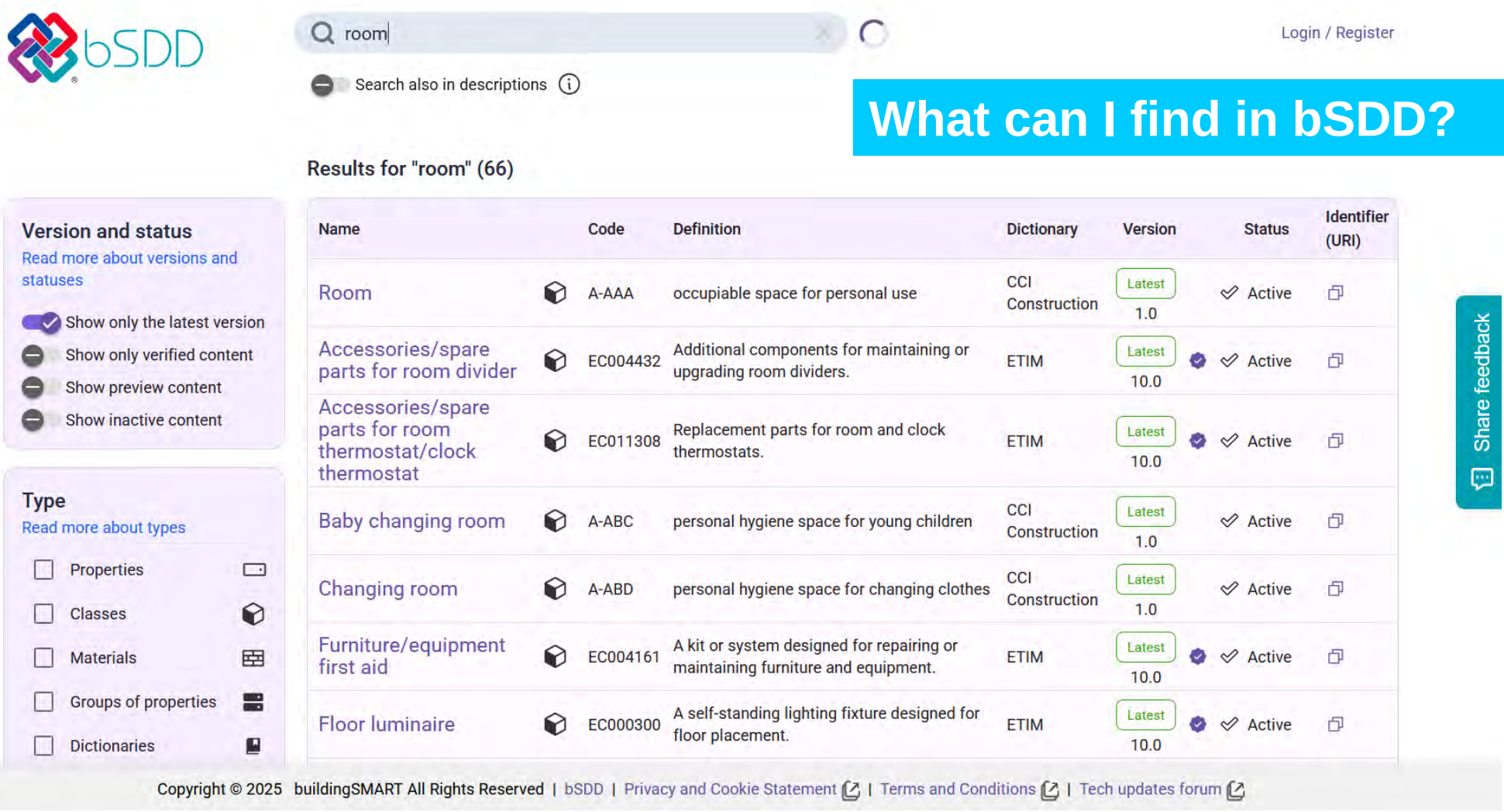
The content is published by independent organisations, spanning international classifications, national standards and company-specific agreements.

70%

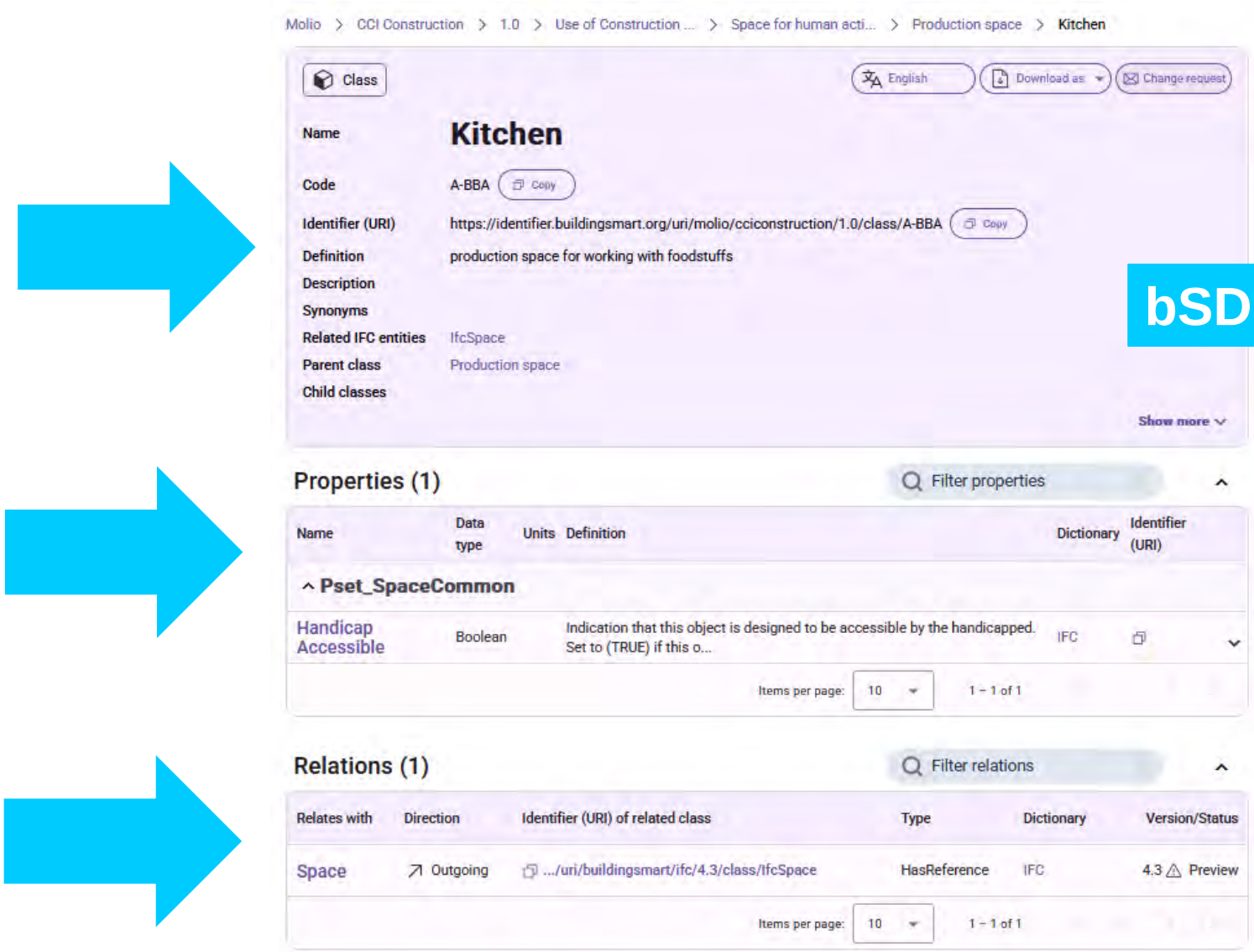
https://www.buildingsmart.org/users/services/buildingsmart-data-dictionary/

buildingSmart Data Dictionaries (bSDD)

What can I find in bSDD?



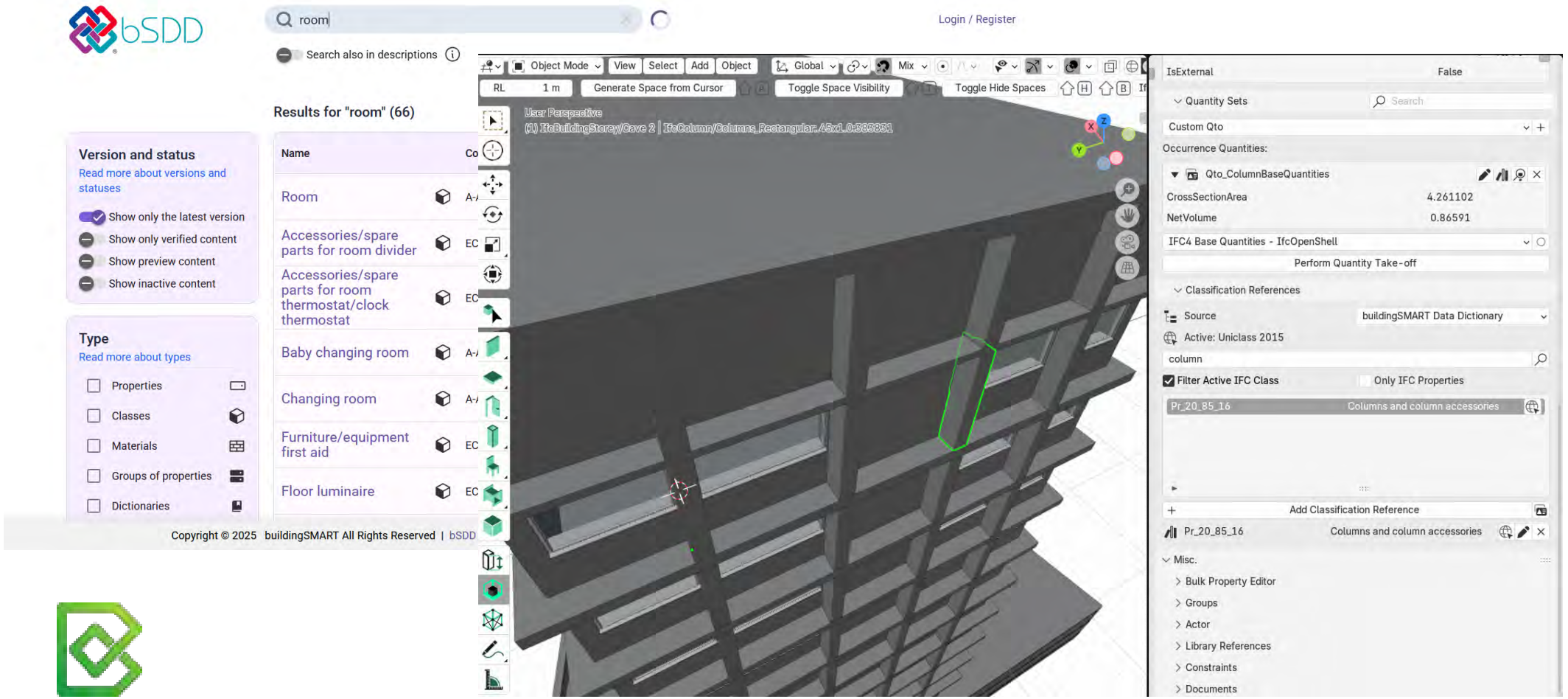
buildingSmart Data Dictionaries (bSDD)



bSDD resources

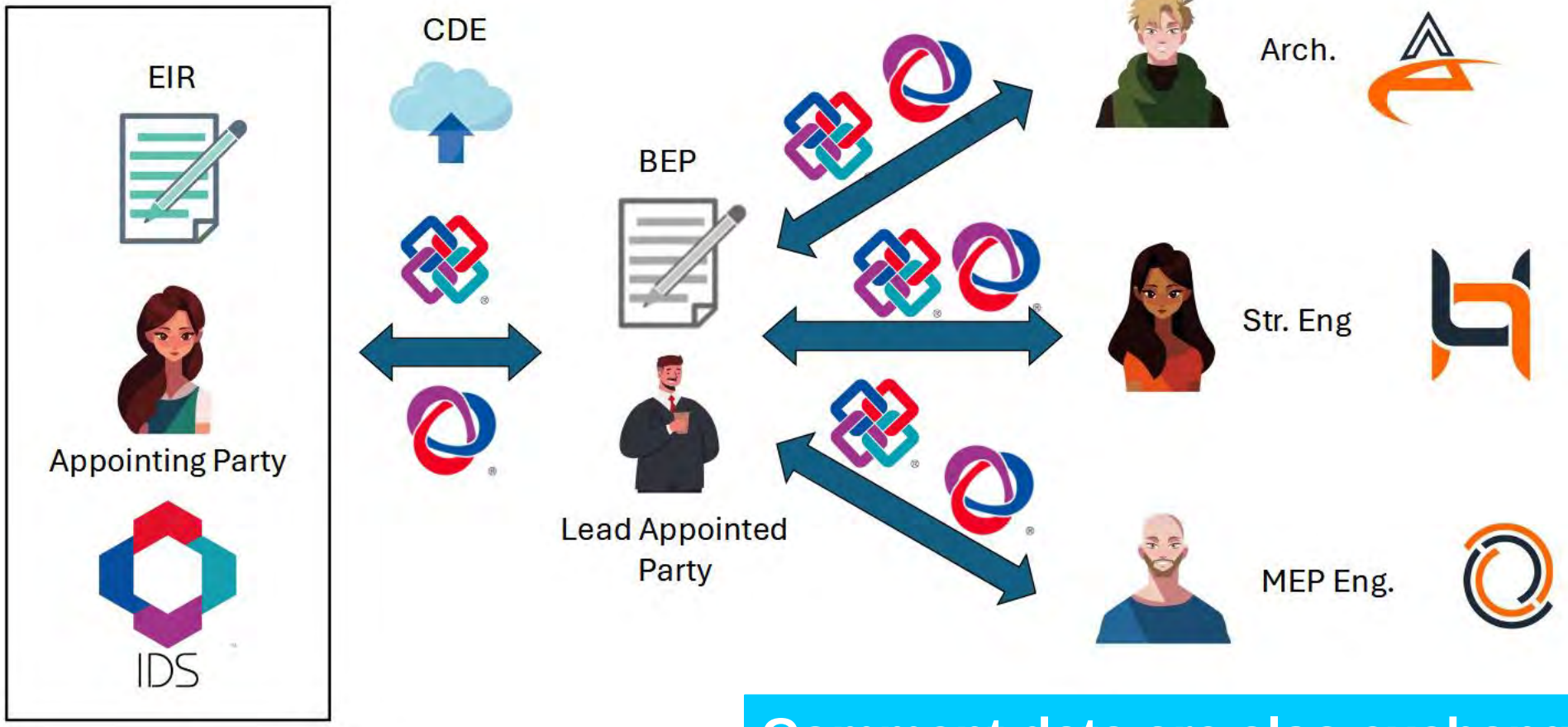
bSDD – Practical use

Let's explore!



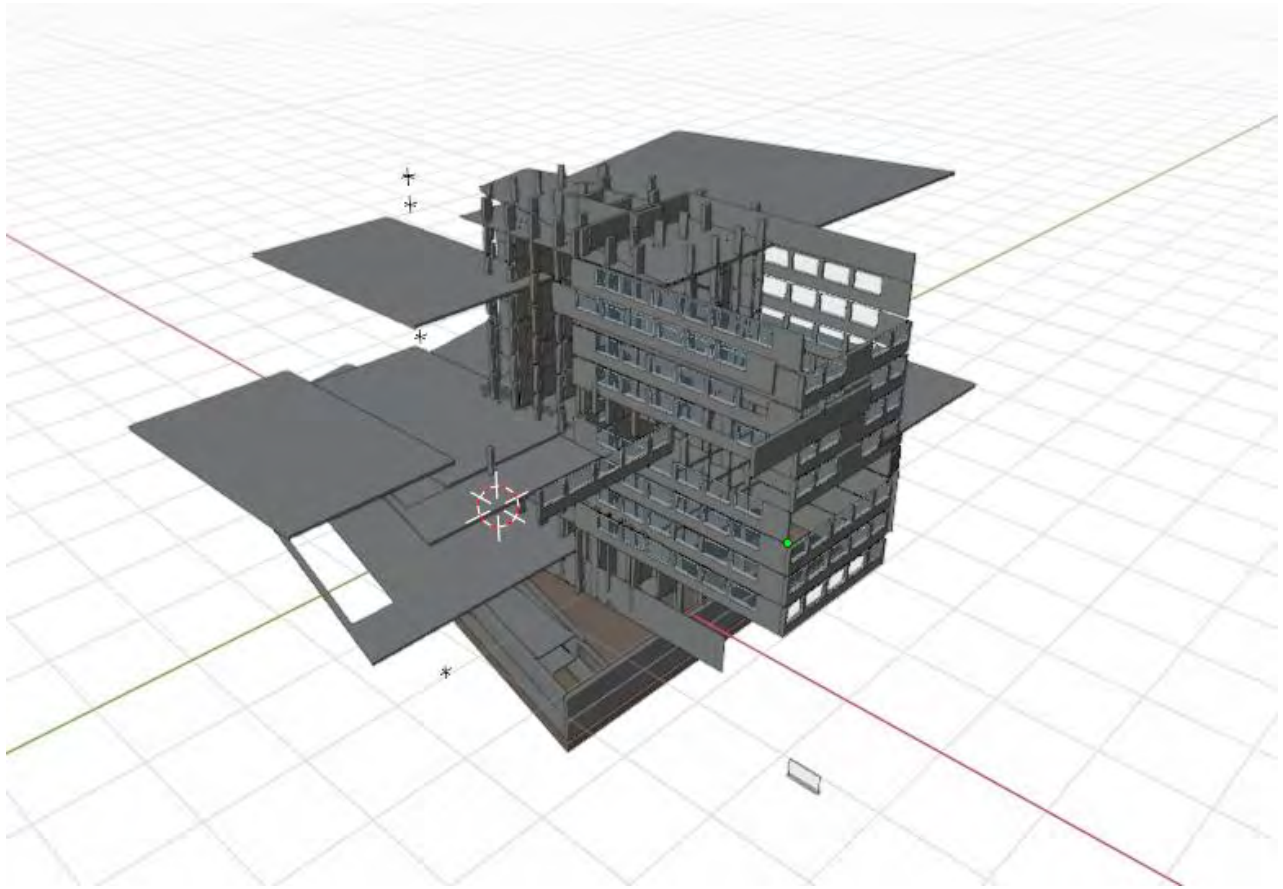
BIM Collaboration Format (BCF) - Context

And here we go again – Information exchange



Comment data are also exchanged

BIM Collaboration Format (BCF) - Context





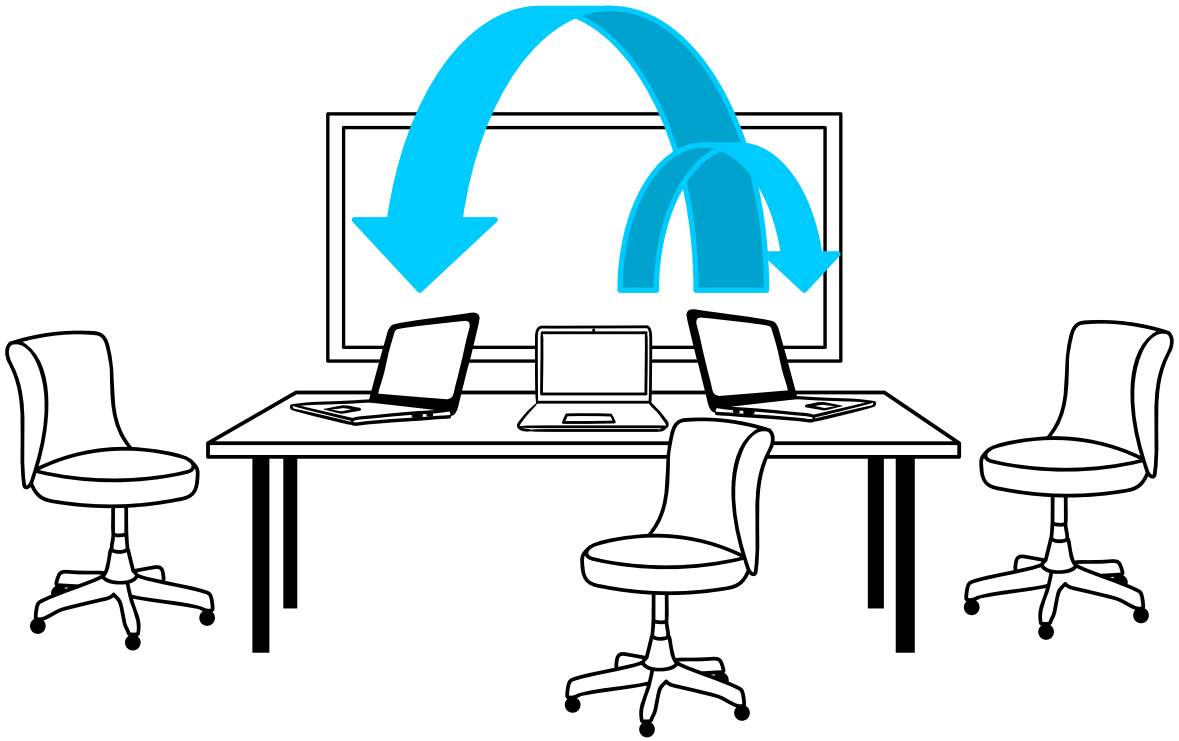
Whatsapp??



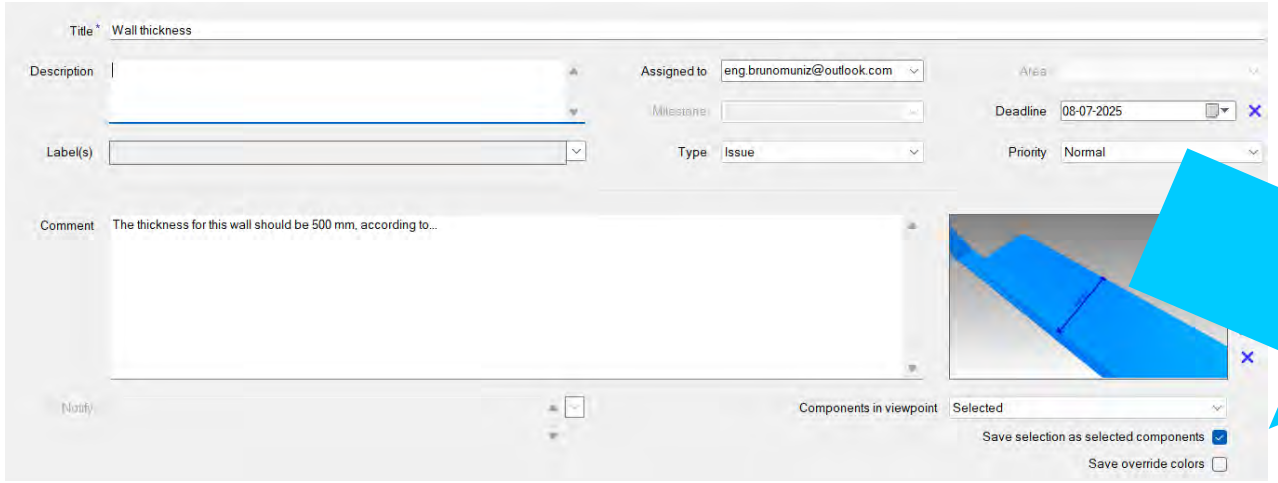
89%

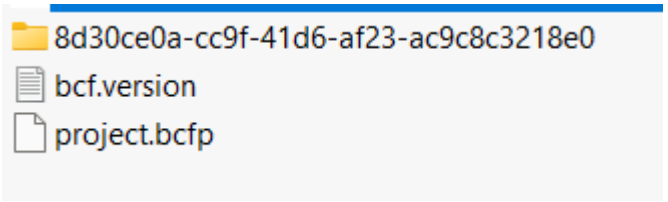
BIM Collaboration Format (BCF) – What is?

Standard to exchange communication data between software.



BCF – What it contains?






```
<?xml version="1.0" encoding="UTF-8"?>
<Markup>
	<Topic Guid="8d30ce0a-cc9f-41d6-af23-ac9c8c3218e0" TopicType="Issue" TopicStatus="Active">
		<Title>Wall thickness</Title>
		<Priority>Normal</Priority>
		<Index>1</Index>
		<CreationDate>2025-07-08T09:10:31+00:00</CreationDate>
		<CreationAuthor>eng.brunomuniz@outlook.com</CreationAuthor>
		<ModifiedDate>2025-07-08T09:10:32+00:00</ModifiedDate>
		<ModifiedAuthor>eng.brunomuniz@outlook.com</ModifiedAuthor>
		<DueDate>2025-07-08T09:00:00+00:00</DueDate>
		<AssignedTo>eng.brunomuniz@outlook.com</AssignedTo>
	</Topic>
	<Comment Guid="dd15b129-0e2a-4532-96ab-63d0ced3d7f0">
		<Date>2025-07-08T09:10:31+00:00</Date>
		<Author>eng.brunomuniz@outlook.com</Author>
		<Comment>The thickness for this wall should be 500 mm, according to...</Comment>
		<Viewpoint Guid="6029c87c-c93e-435d-a8d7-b9722875cba7" />
		<ModifiedDate>2025-07-08T09:10:31+00:00</ModifiedDate>
		<ModifiedAuthor>eng.brunomuniz@outlook.com</ModifiedAuthor>
	</Comment>
	<Viewpoints Guid="6029c87c-c93e-435d-a8d7-b9722875cba7">
		<Viewpoint>viewpoint.bcfv</Viewpoint>
		<Snapshot>snapshot.png</Snapshot>
	</Viewpoints>
</Markup>
```

Diving into BCF

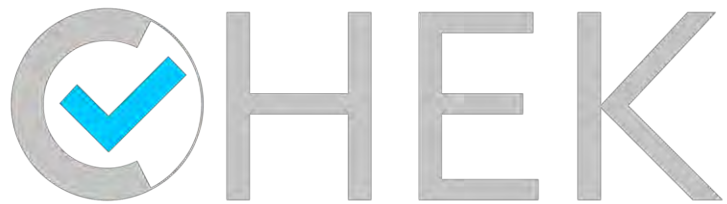
BCF – Structure and hands-on

BIM Collaboration Format v3.0 Technical Documentation



https://github.com/BuildingSMART/BCF-XML/tree/release_3_0/Documentation

Let’s go to the docs again!



DIGITAL BUILDING PERMIT

DIGITAL BUILDING PERMIT

Digital Transformation in Building Permits

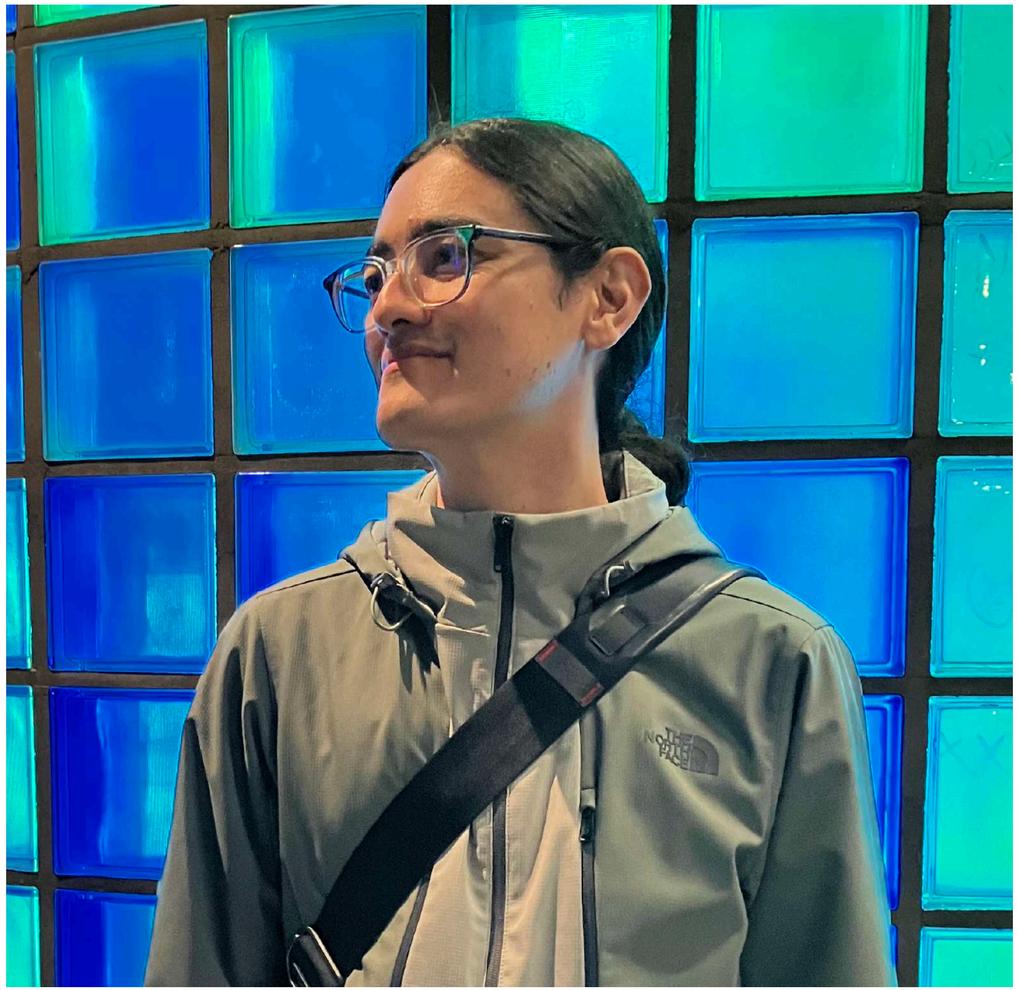
Module 5 - 3D city modelling: background and standards

9th July 2025

Funded by
the European Union

About me

- Ken Arroyo Ohori
- Researcher and lecturer at TU Delft, the Netherlands
- k.ohori@tudelft.nl



Module 5 contents

- Foundations of 2D and 3D GIS
- Processing 2D and 3D geodata
- 3D city models

Recommended material

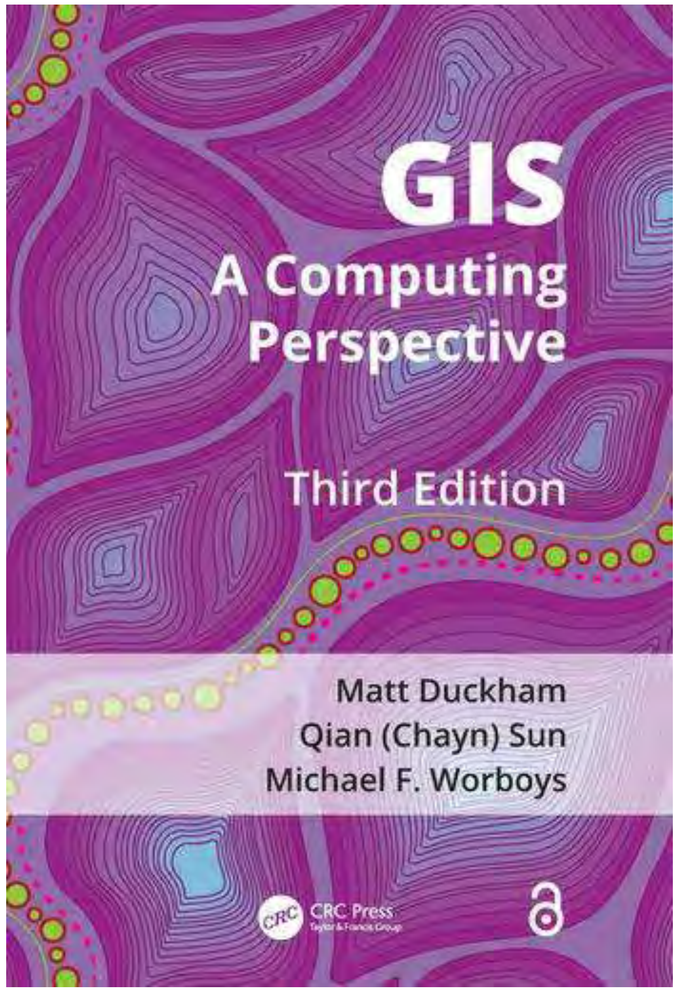
- Otto Huisman and Rolf A. de By. **Principles of Geographic Information Systems**. 4th Edition. 2009.

- https://archive.org/details/PrinciplesOfGeographicInformationSystemsBYOttoHuismanAndRolfA.De



Recommended material

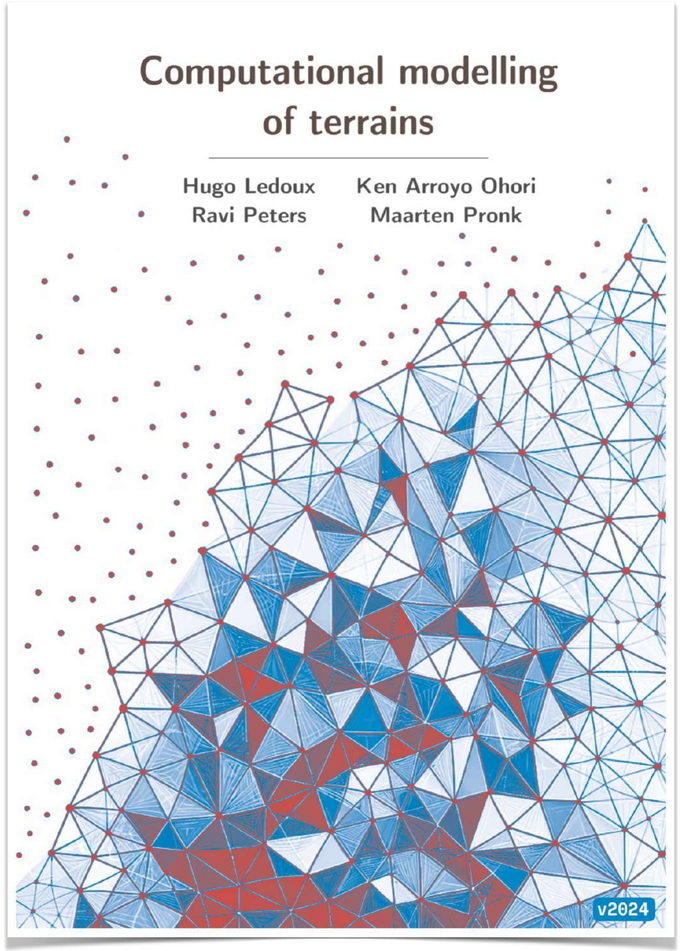
- Matt Duckham, Qian (Chayn) Sun and Michael F. Worboys. **GIS: A Computing Perspective**. 3rd Edition. 2024.



Recommended material

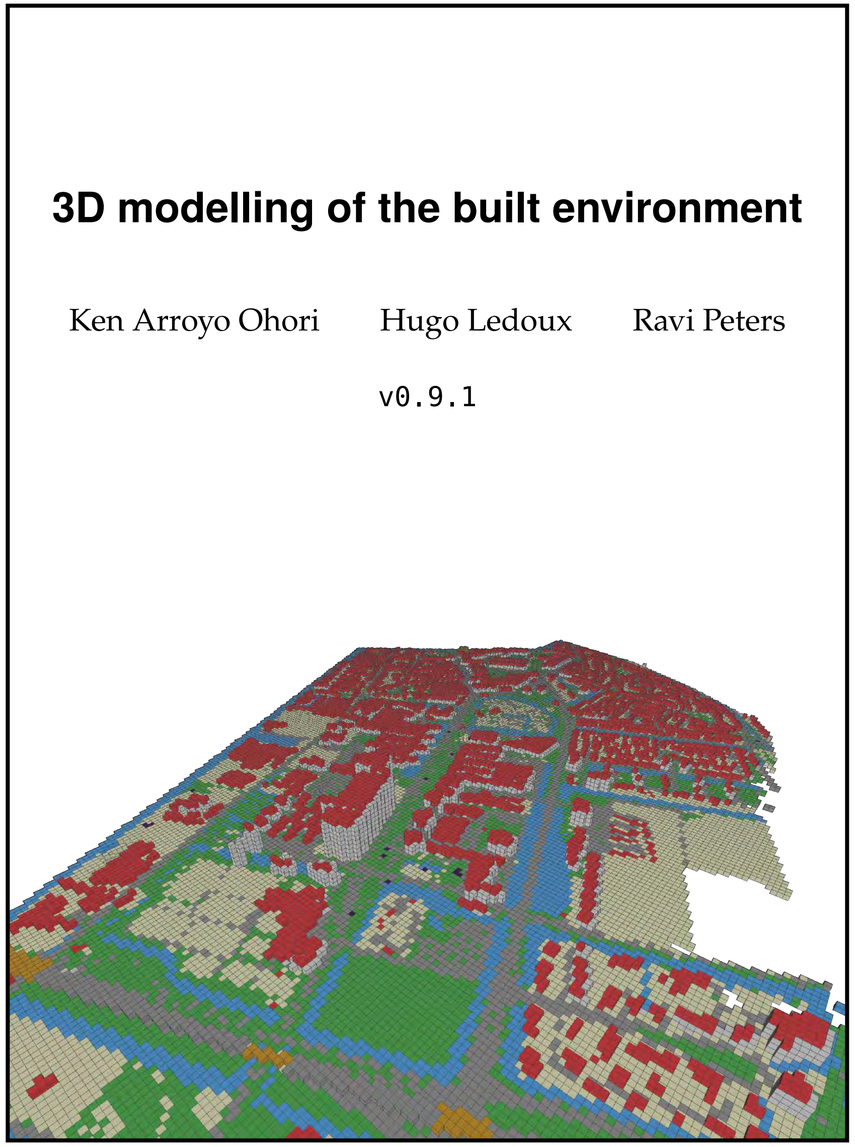
- Hugo Ledoux, Ken Arroyo Ohori, Ravi Peters and Maarten Pronk. **Computational modelling of terrains**.

- https://tudelft3d.github.io/terrainbook/



Recommended material

- Ken Arroyo Ohori, Hugo Ledoux and Ravi Peters. **3D modelling of the built environment**.
- https://github.com/tudelft3d/3dbook/releases/tag/v0.9.1



Foundations of 2D and 3D GIS contents

- Why a GIS? What is a GIS?
- Geographic phenomena: fields and objects
- Computer representations: vectors and rasters
- Georeferencing
- Practical session with QGIS

Why a GIS?

- An **urban planner** might want to assess the extent of urban fringe growth in their city, and quantify the population growth that some suburbs are witnessing. They might also like to understand why these particular suburbs are growing and others are not.

- A **mining engineer** could be interested in determining which prospective copper mines should be selected for future exploration, taking into account parameters such as extent, depth and quality of the ore body, amongst others.

- A **geoinformatics engineer** hired by a telecommunications company may want to determine the best sites for the company's cell phone towers, taking into account various cost factors such as land prices, shape of the terrain, tall buildings, etc.



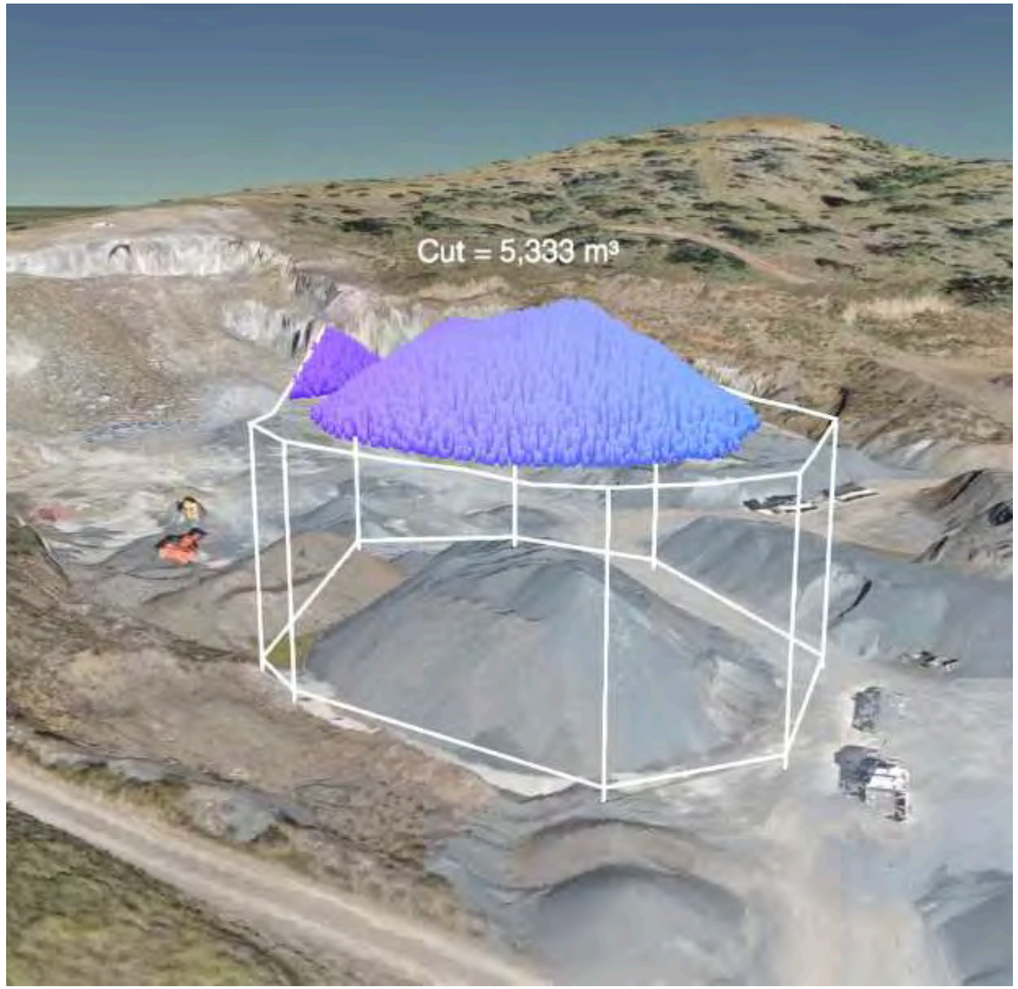
3D interface, aspern Seestadt in Vienna. Screenshot courtesy Wien3420

Why a GIS?

- An **urban planner** might want to assess the extent of urban fringe growth in their city, and quantify the population growth that some suburbs are witnessing. They might also like to understand why these particular suburbs are growing and others are not.

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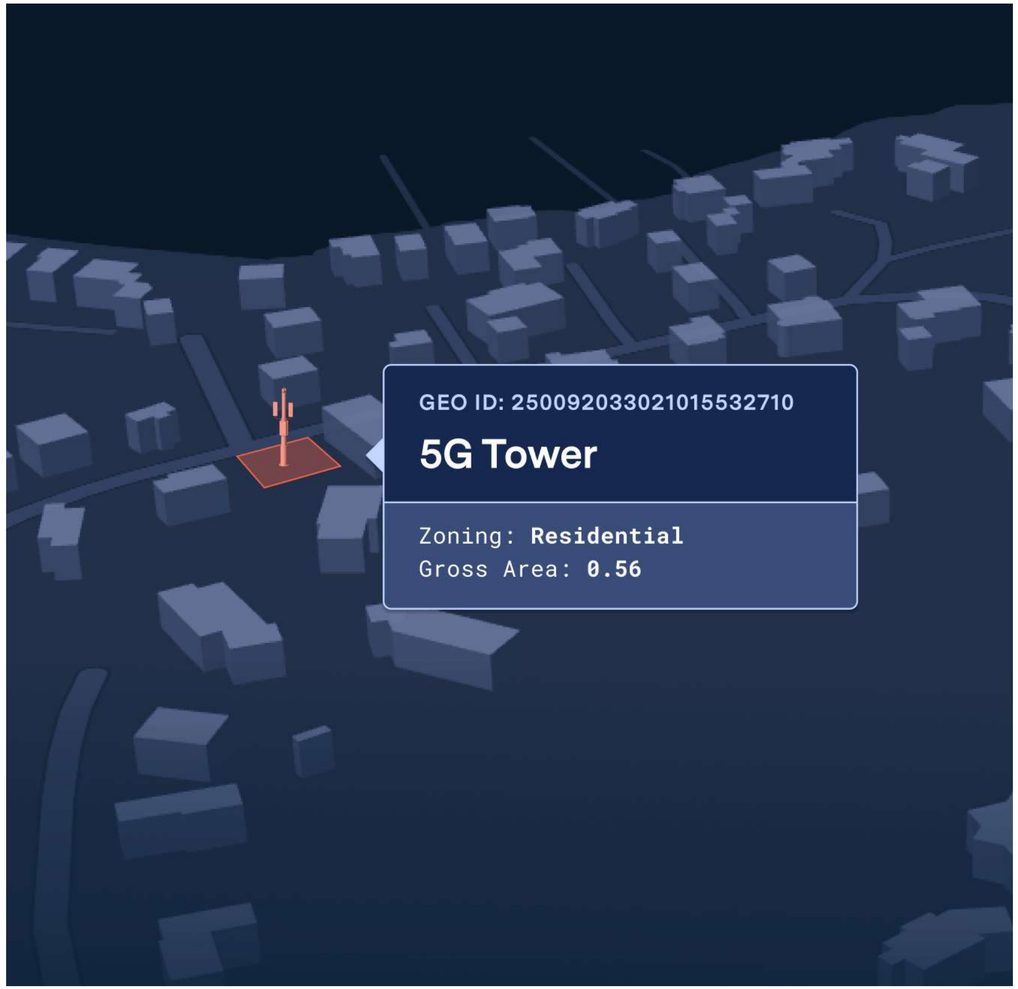
Source: GIS Navigator

Why a GIS?

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Source: Urban Footprint

What is a GIS?

Short for: Geographic Information System

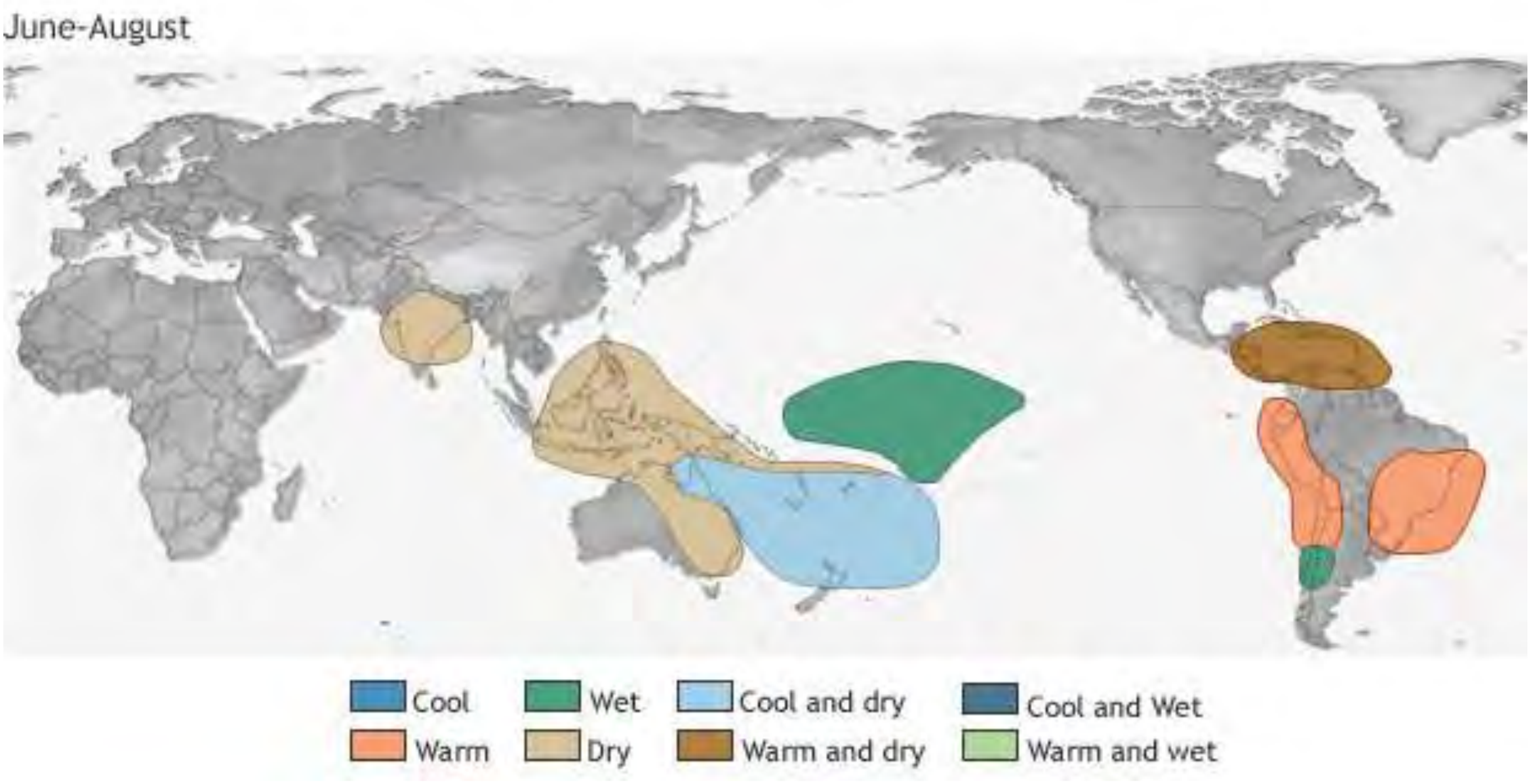
A GIS is a computer-based system that provides the following four sets of capabilities to handle georeferenced data:

- data capture and preparation,
- data management (storage and maintenance),
- data manipulation and analysis, and
- data presentation.



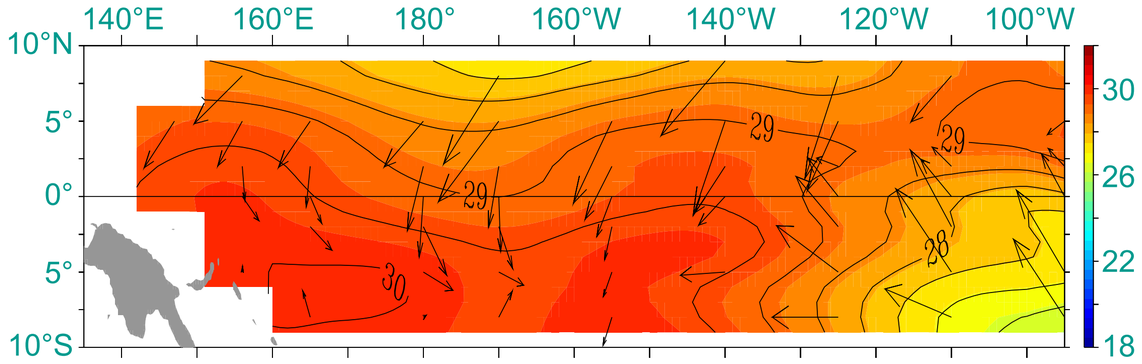
Image: macrovector in Freepik

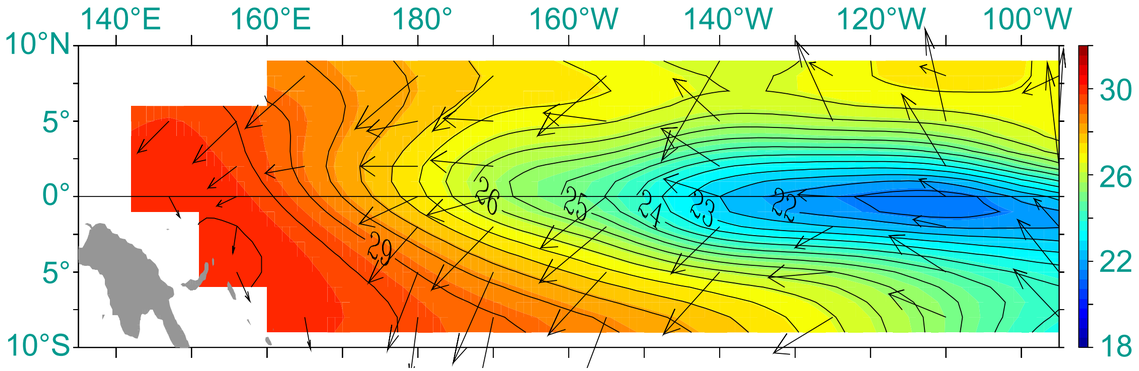
Example: studying the El Niño phenomenon

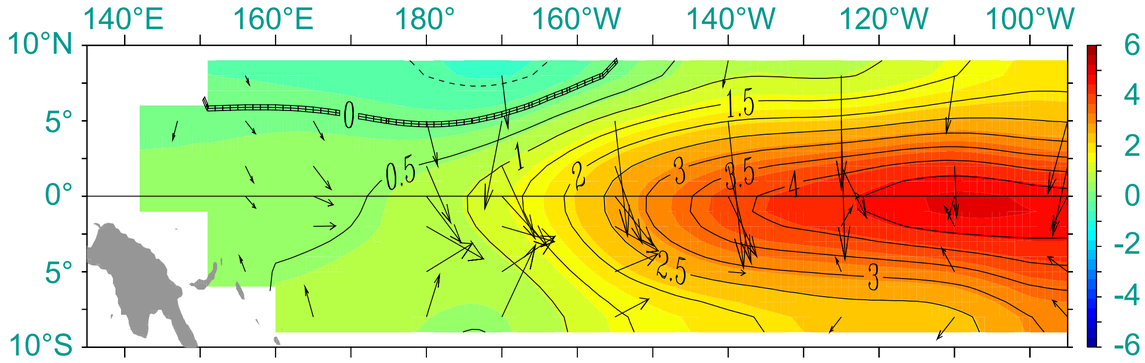


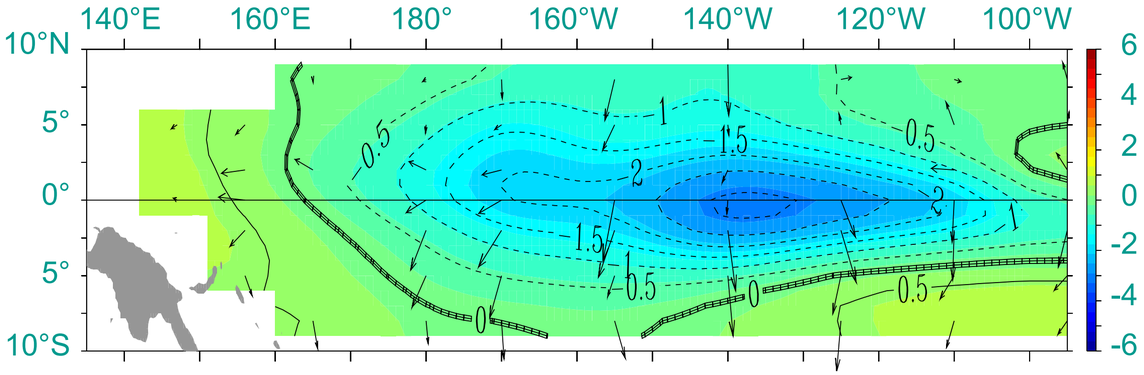
Example: studying the El Niño phenomenon

Upper figures: absolute values of average SST [°C] and WS [m/s]





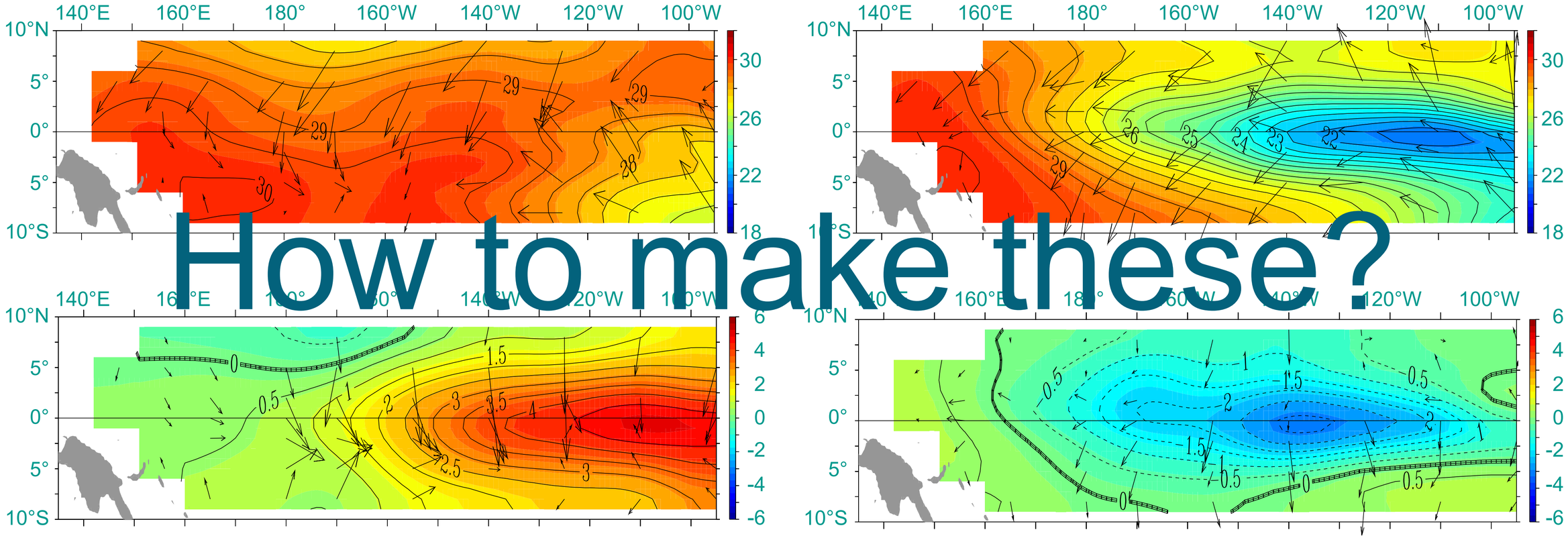




Lower figures: differences with normal situation

Example: studying the El Niño phenomenon

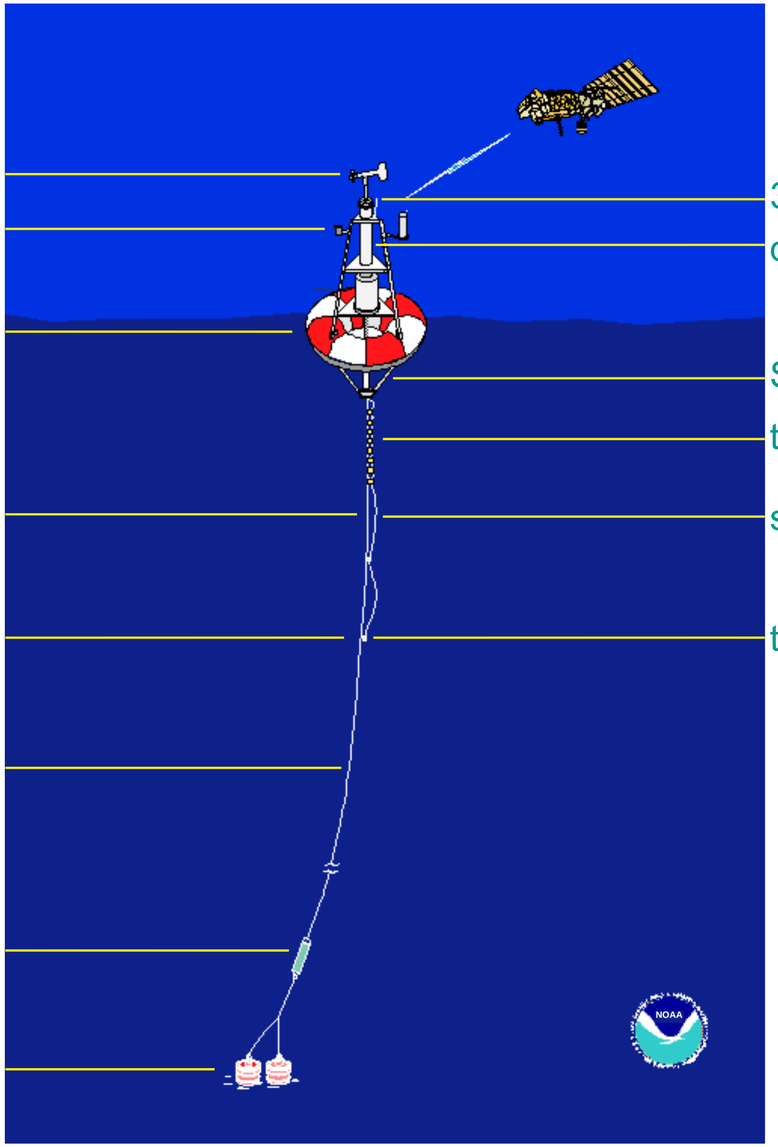
Upper figures: absolute values of average SST [°C] and WS [m/s]



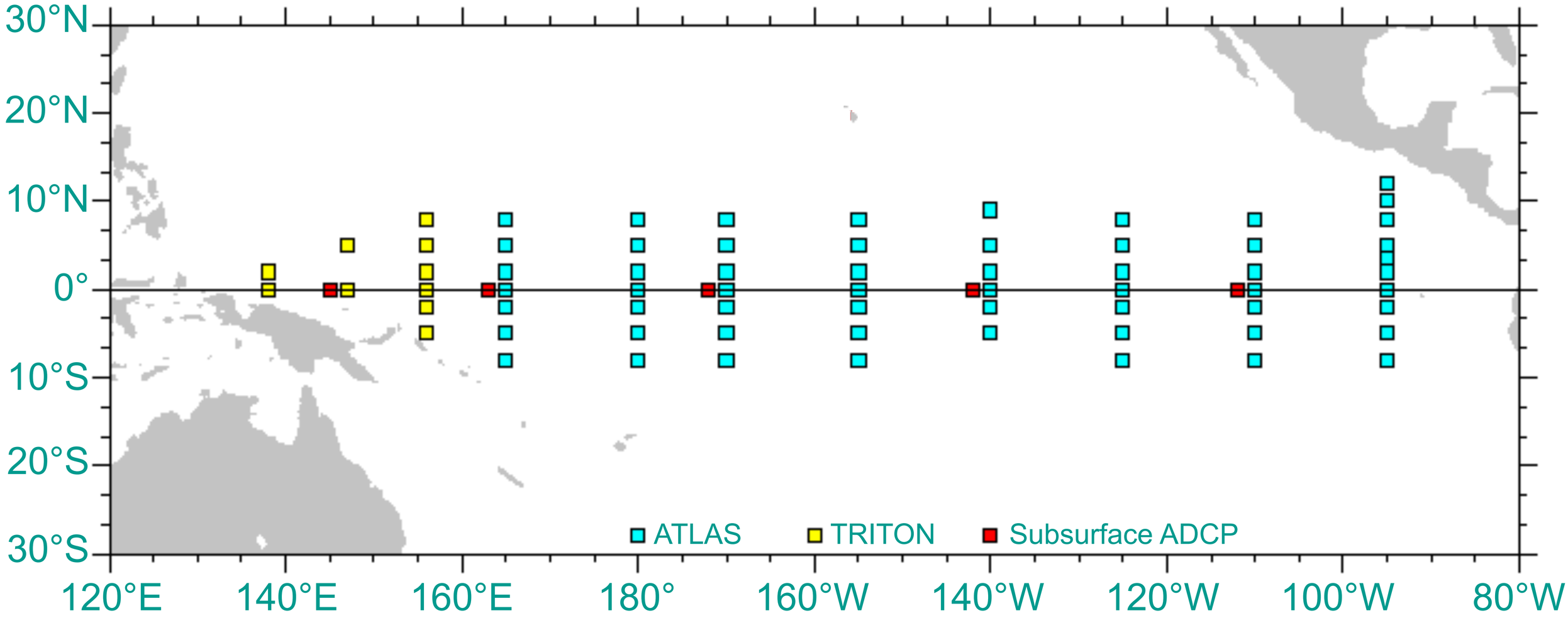
How to make these?

Lower figures: differences with normal situation

Step 1: collection of data



Step 2: data entry



Step 2: data entry

DAYMEASUREMENTS

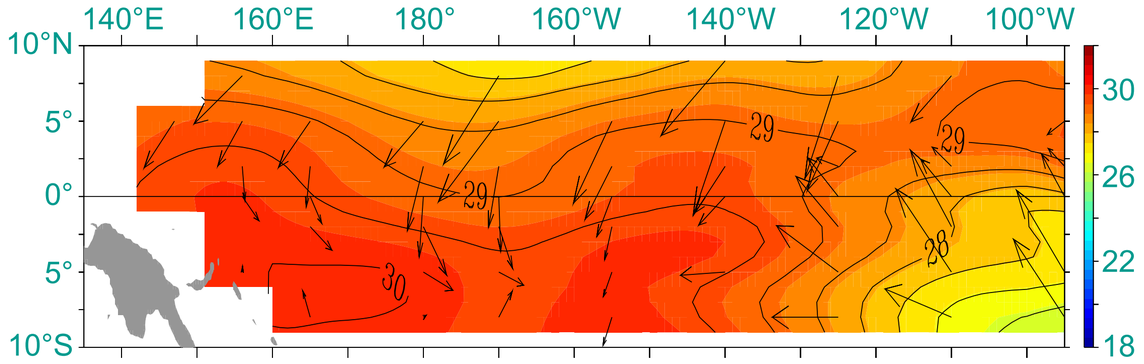
Buoy	*Date*	*SST*	*WS*	*Humid*	*Temp10*	...
B0749	1997/12/03	28.2 °C	NNW 4.2	72%	22.2 °C	...
B9204	1997/12/03	26.5 °C	NW 4.6	63%	20.8 °C	...
B1686	1997/12/03	27.8 °C	NNW 3.8	78%	22.8 °C	...
B0988	1997/12/03	27.4 °C	N 1.6	82%	23.8 °C	...
B3821	1997/12/03	27.5 °C	W 3.2	51%	20.8 °C	...
B6202	1997/12/03	26.5 °C	SW 4.3	67%	20.5 °C	...
B1536	1997/12/03	27.7 °C	SSW 4.8	58%	21.4 °C	...
B0138	1997/12/03	26.2 °C	W 1.9	62%	21.8 °C	...
B6823	1997/12/03	23.2 °C	S 3.6	61%	22.2 °C	...
...	...	...	...	...	...	...

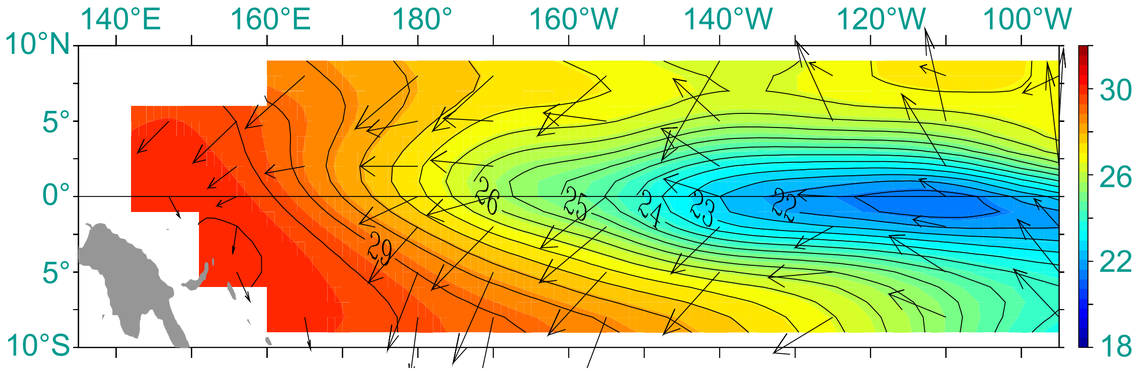
Step 3: data analysis

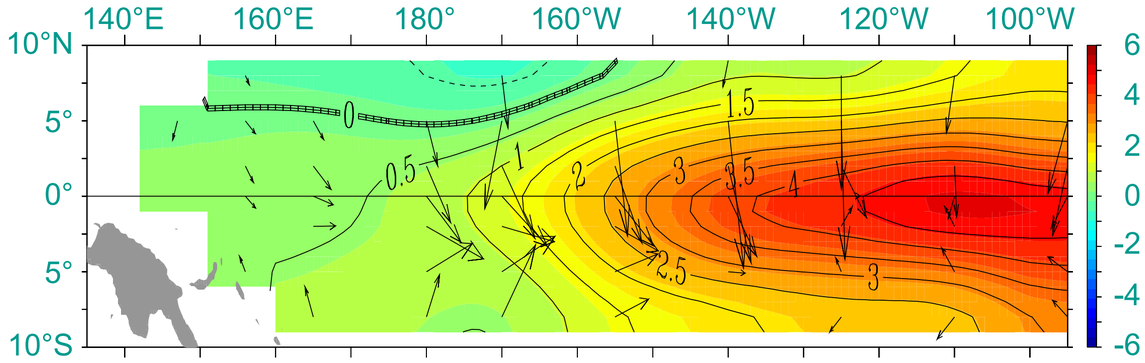
Buoy	*Geographic position*	*Dec. 1997 avg. SST*
B0789	(165° E, 5° N)	28.02 °C
B7504	(180° E, 0° N)	27.34 °C
B1882	(110° W, 7°30’ S)	25.28 °C
. . .	. . .	. . .

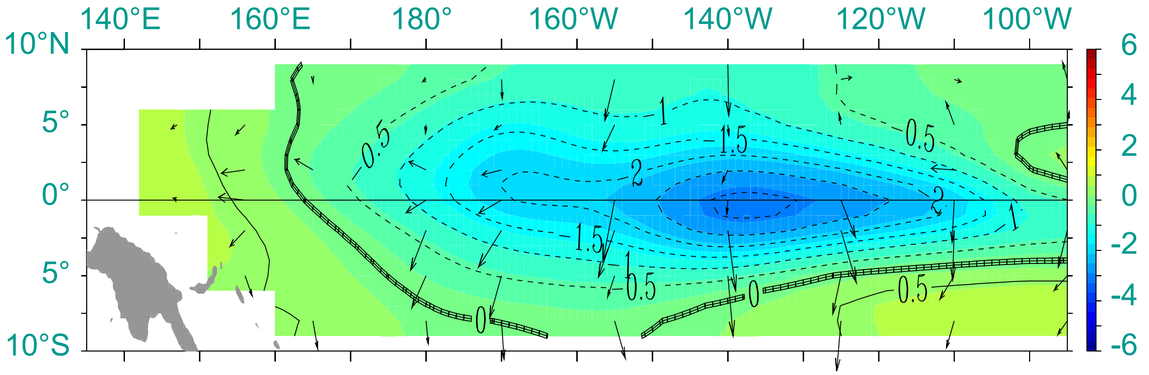
Step 4: data presentation

Upper figures: absolute values of average SST [°C] and WS [m/s]







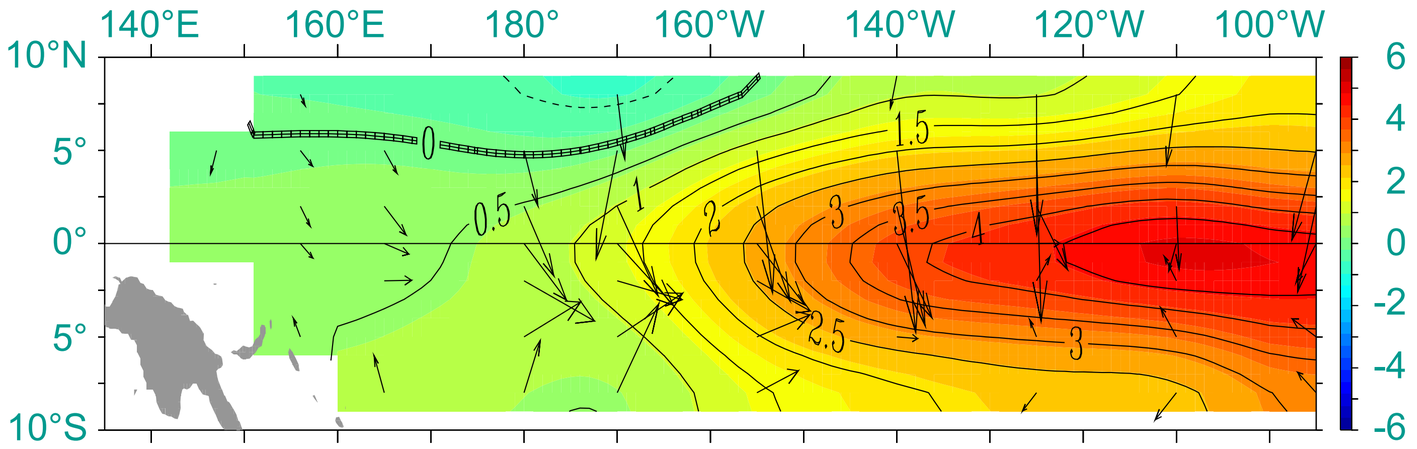


Lower figures: differences with normal situation

Step 4: data presentation

Some elements:

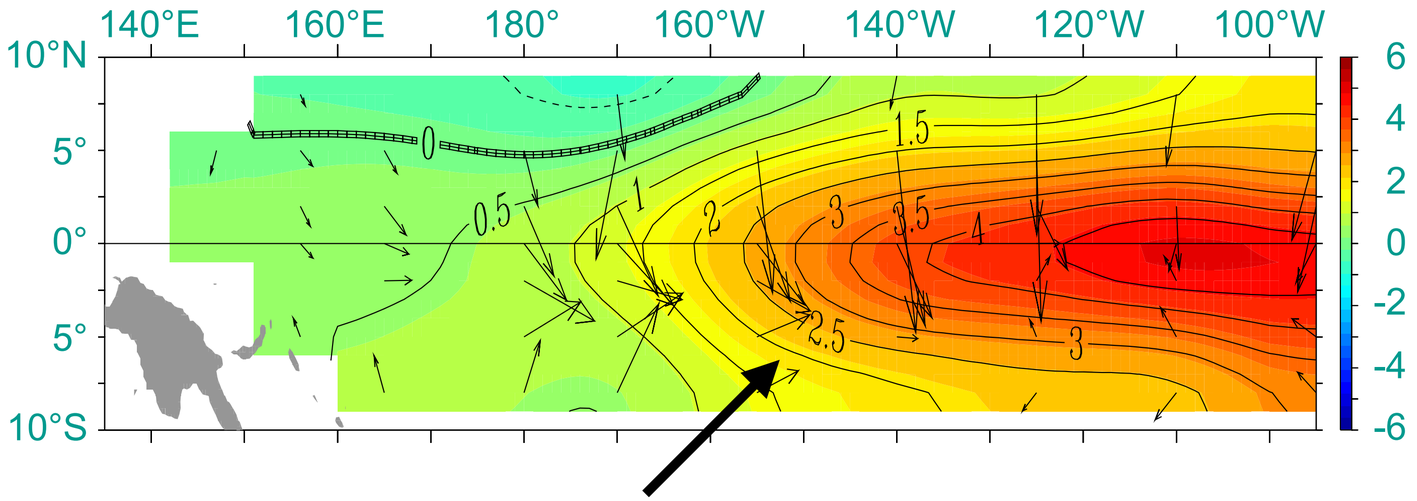
- contour lines
- colour selection
- coordinates
- legend



Step 4: data presentation

Some elements:

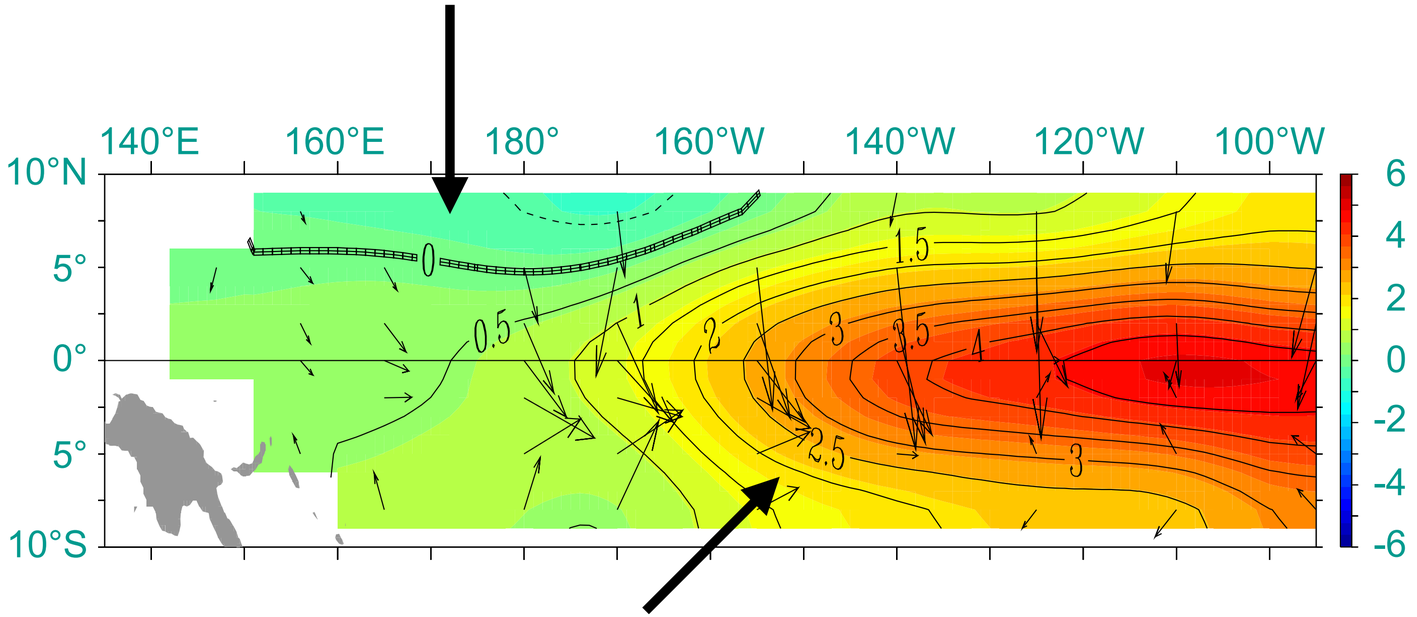
- contour lines
- colour selection
- coordinates
- legend



Step 4: data presentation

Some elements:

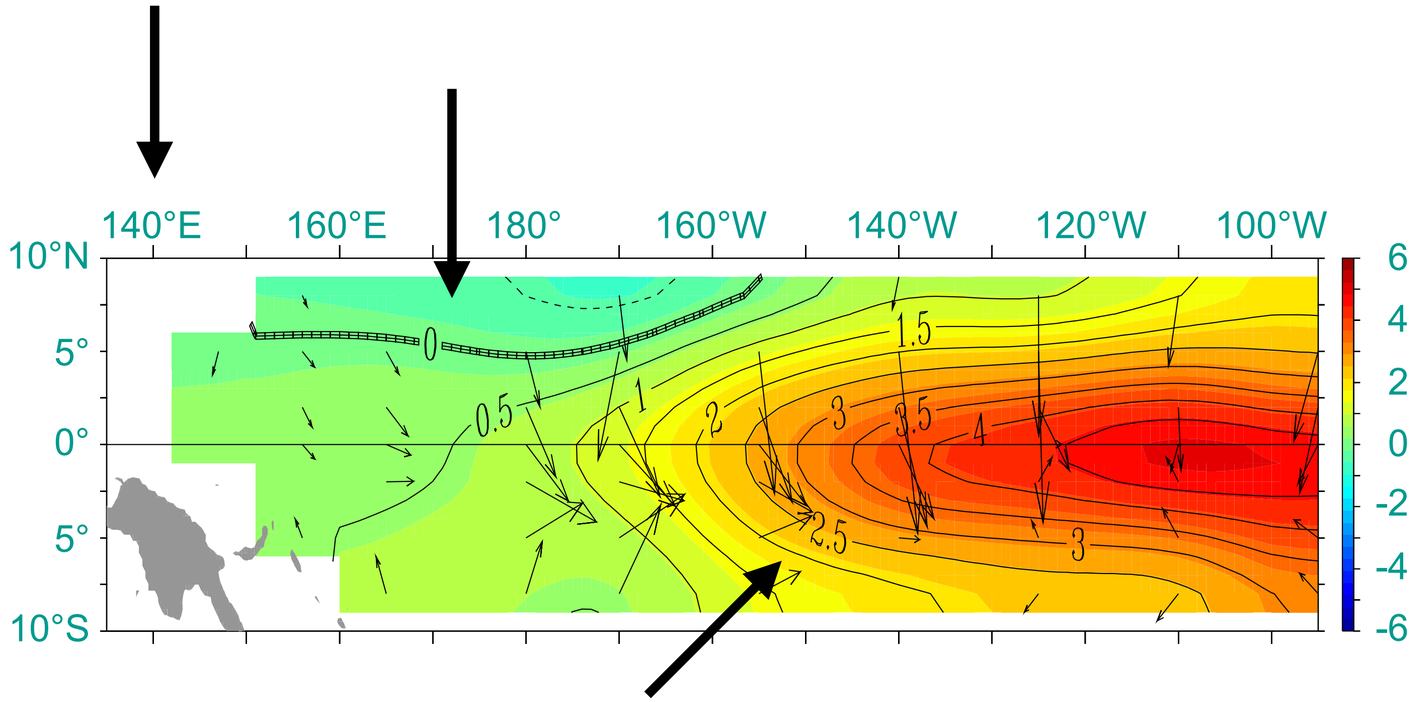
- contour lines
- colour selection
- coordinates
- legend



Step 4: data presentation

Some elements:

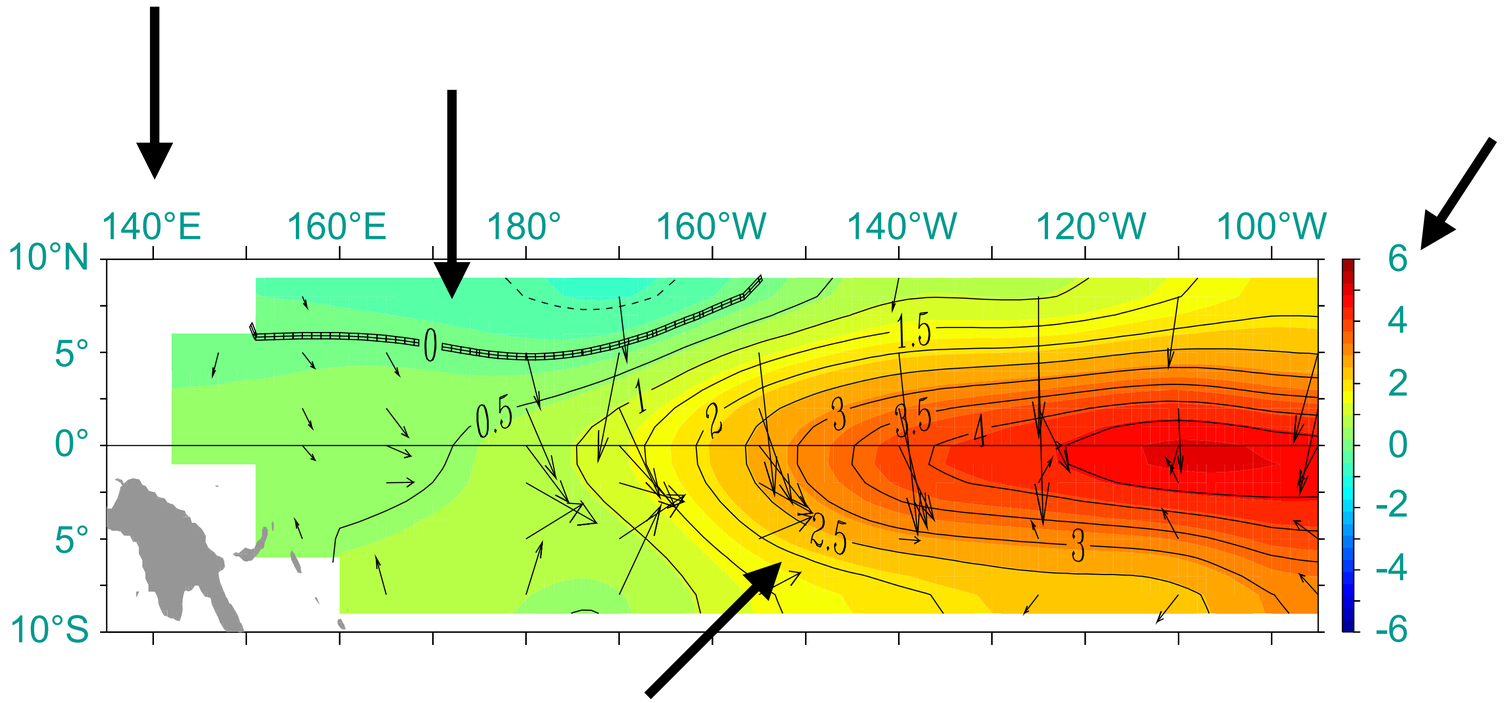
- contour lines
- colour selection
- coordinates
- legend



Step 4: data presentation

Some elements:

- contour lines
- colour selection
- coordinates
- legend



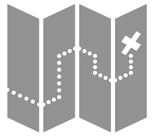
What is a GIS in practice?

Depending on the interest of a particular application, a GIS can be considered to be:

- data storage / (geo)database,
- toolbox / a set of libraries,
- technology,
- data source,
- field of science.



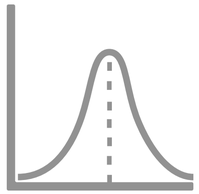
Related terms



- Geographic information science (GIScience): discipline

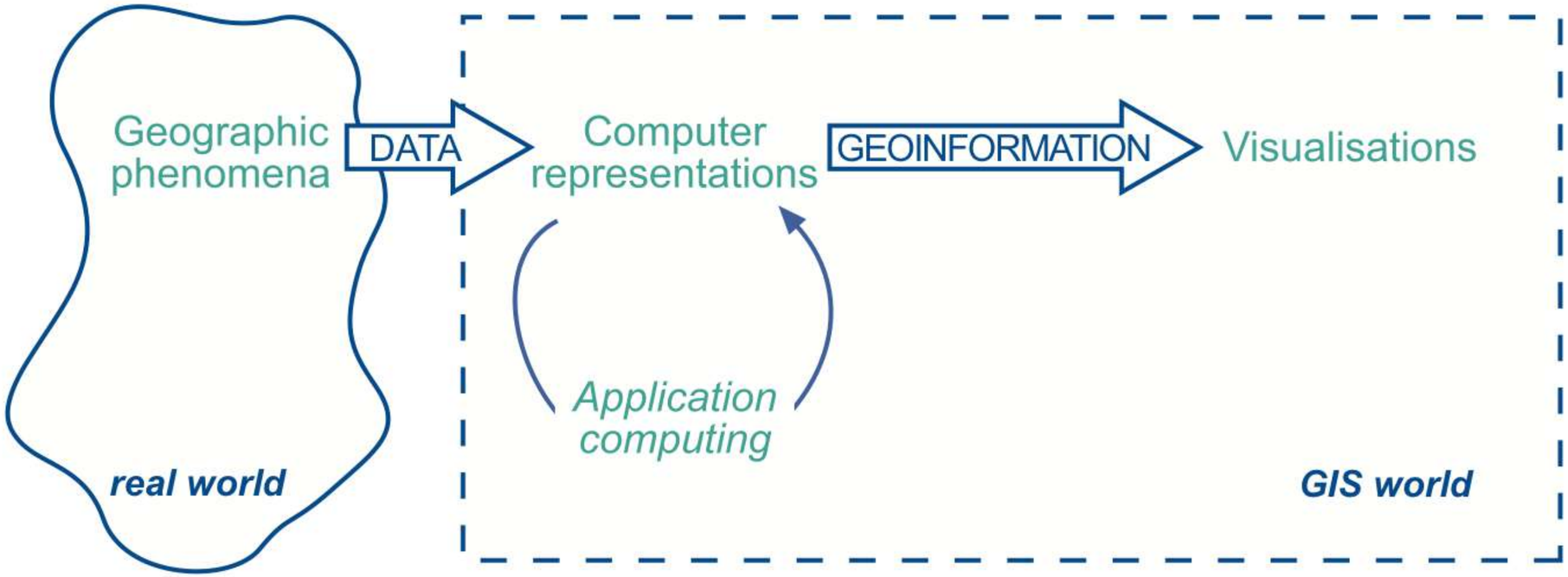


- Geomatics: encompasses also acquisition of data and applications



- Geoinformatics: focus on computational methods

What is covered in a GIS?



- Why a GIS? What is a GIS?
- Geographic phenomena: fields and objects
- Computer representations: vectors and rasters
- Georeferencing
- QGIS demo & practical session

Geographic phenomena

- Entity or process that can be described, has a location in space and can be assigned a time at which it is present. There are two types:
  - **Fields**, which have a value for every point in the study area. Can be continuous or discrete.
  - **Objects**, which populate the study area and are are usually well-distinguished, discrete, and bounded entities. The space between them is potentially ‘empty’ or undetermined.

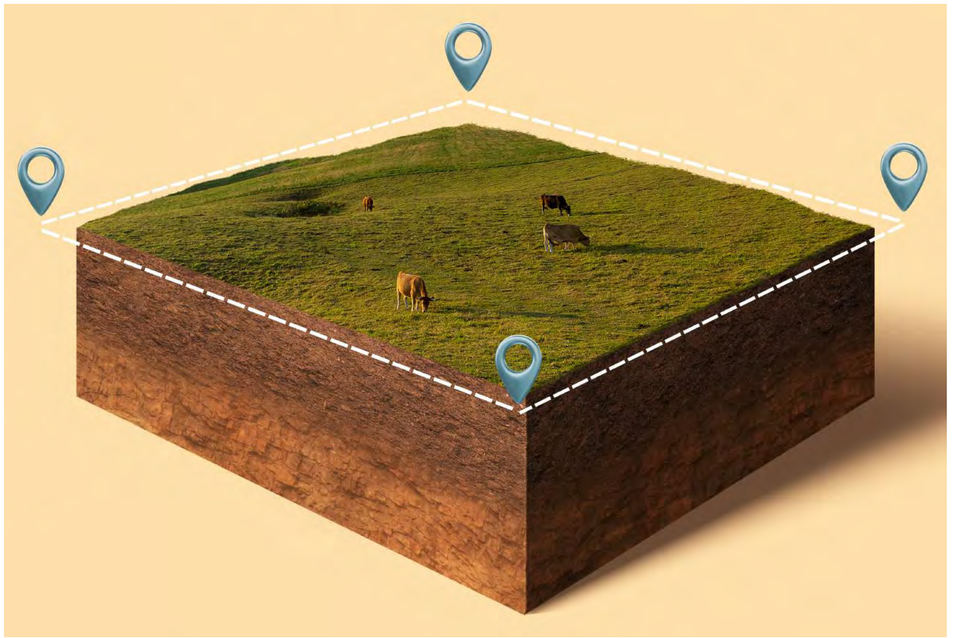
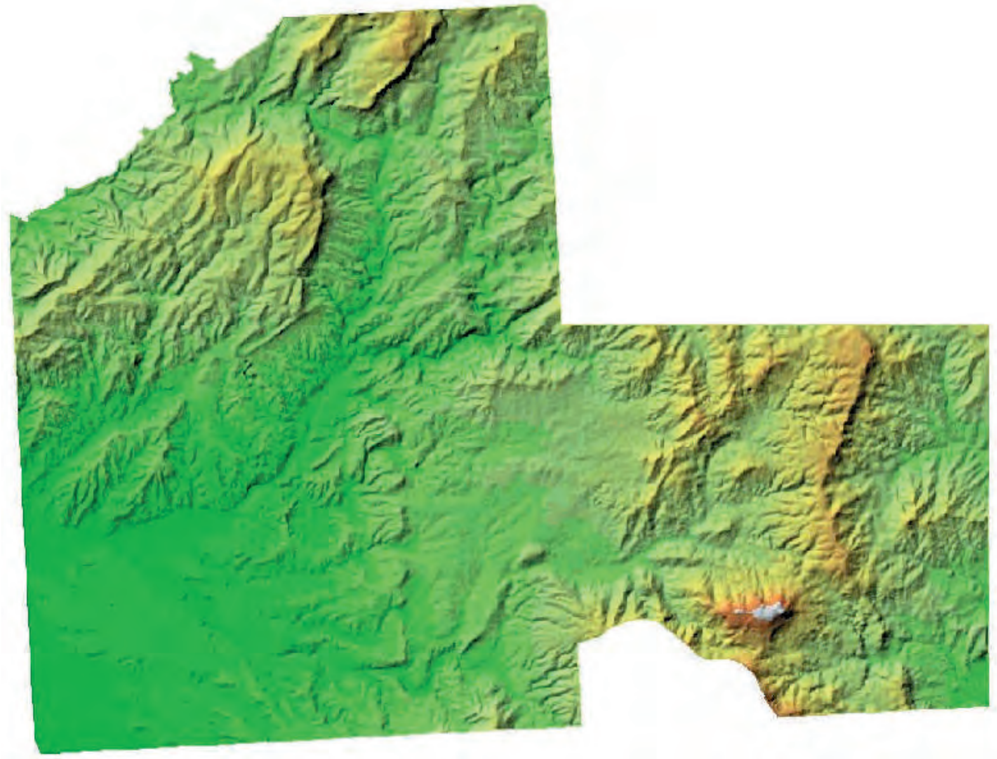


Image: Freepik

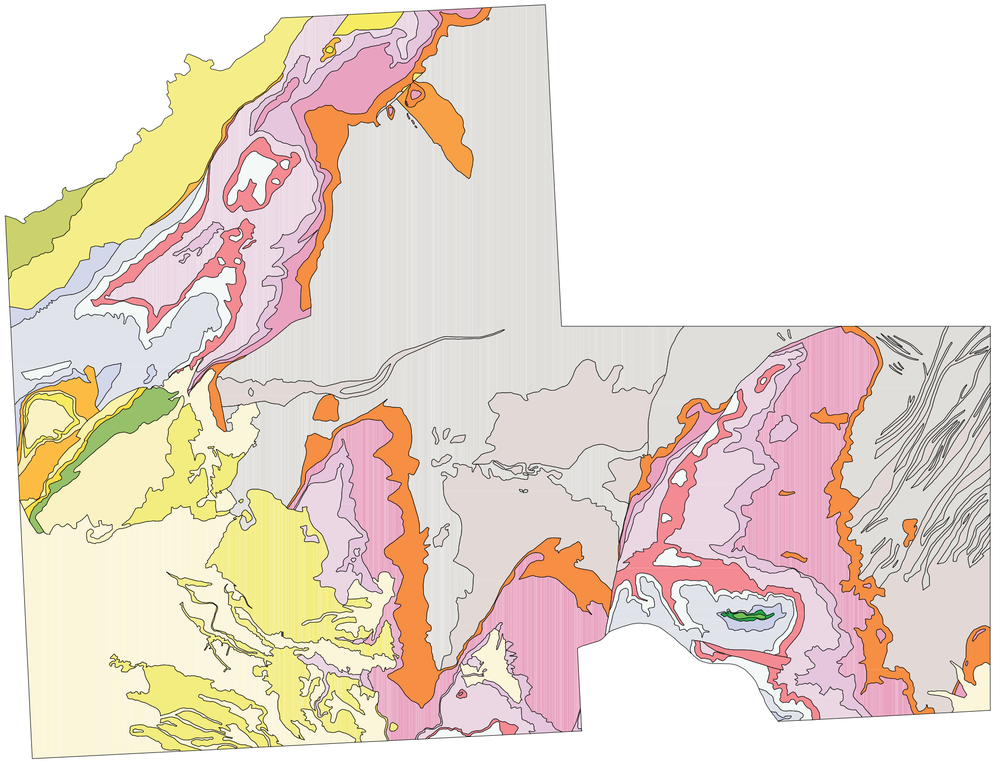
Geographic phenomena: fields (continuous)

- **In 2D:**
  - terrain elevation
  - soil salinity
- **Also in 3D:**
  - temperature
  - humidity
  - air pressure

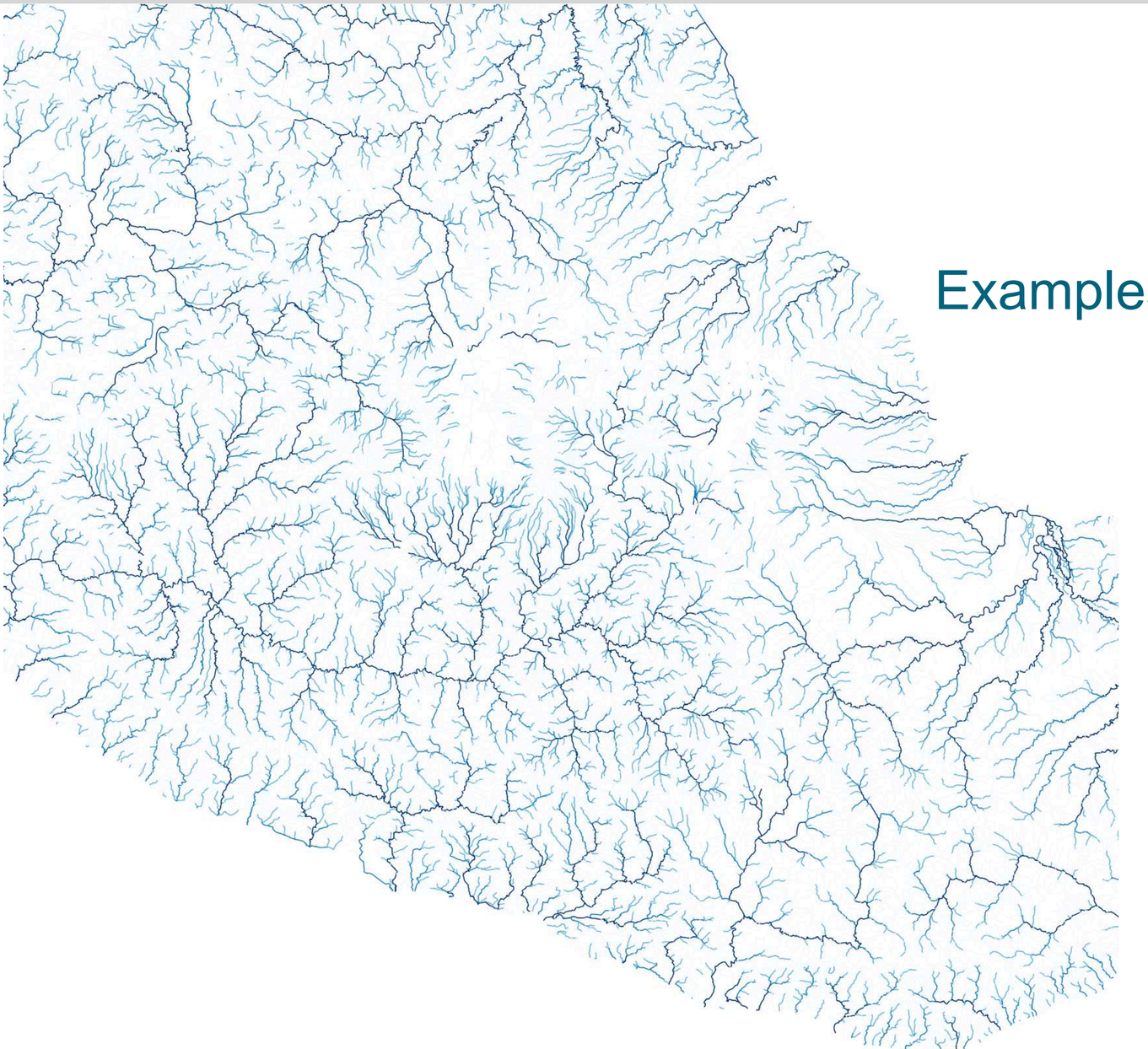


Geographic phenomena: fields (discrete)

- **In 2D:**
  - soil type
  - land use
  - vegetation type
- **Also in 3D:**
  - geological classes
  - building storeys



Geographic phenomena: objects



Examples:

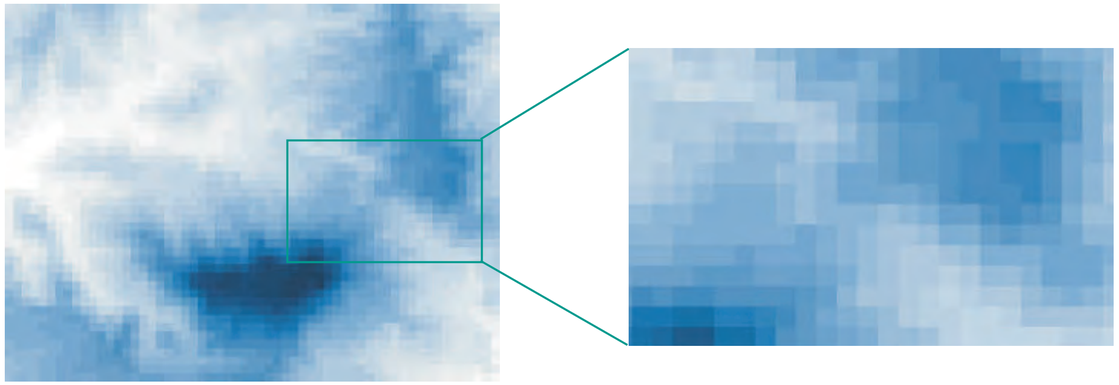
- cities (as points or areas)
- roads (as lines)
- buildings (in 3D)
- hydrological network

Computer representations: vector and raster

- Two ways to represent geographic phenomena in a computer:

rasters

have 2D or 3D grids of cells, each of which has a value;



vectors

are discrete shapes (e.g. points, lines, polygons and polyhedra) with precise boundaries.



Computer representations: vector and raster

- What is the relationship between fields/objects and rasters/vectors?
  - **fields** tend to be represented as **rasters**;
  - **objects** tend to be represented as **vectors;**
- But there are many exceptions!

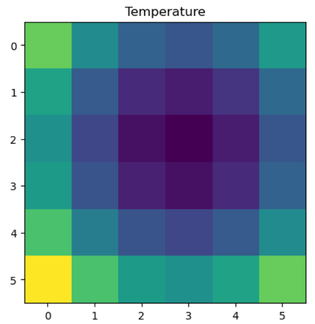
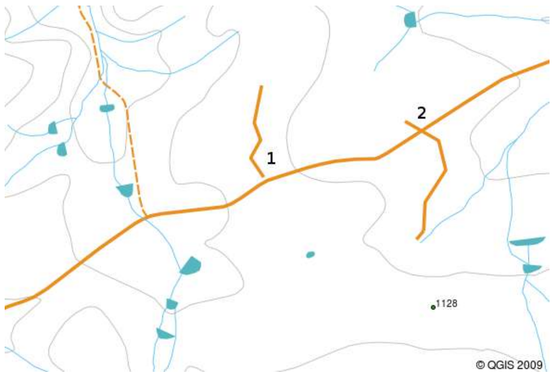
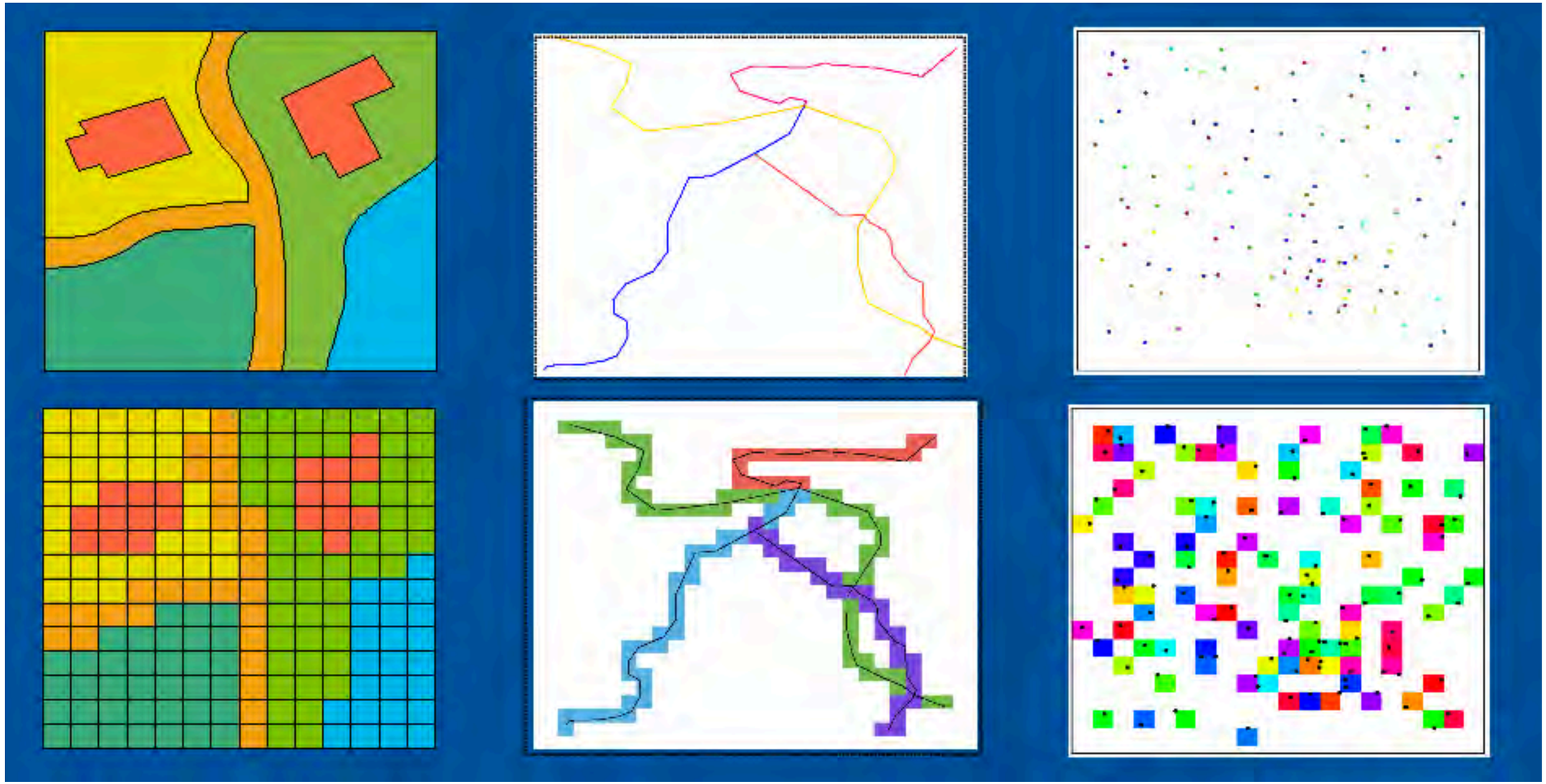


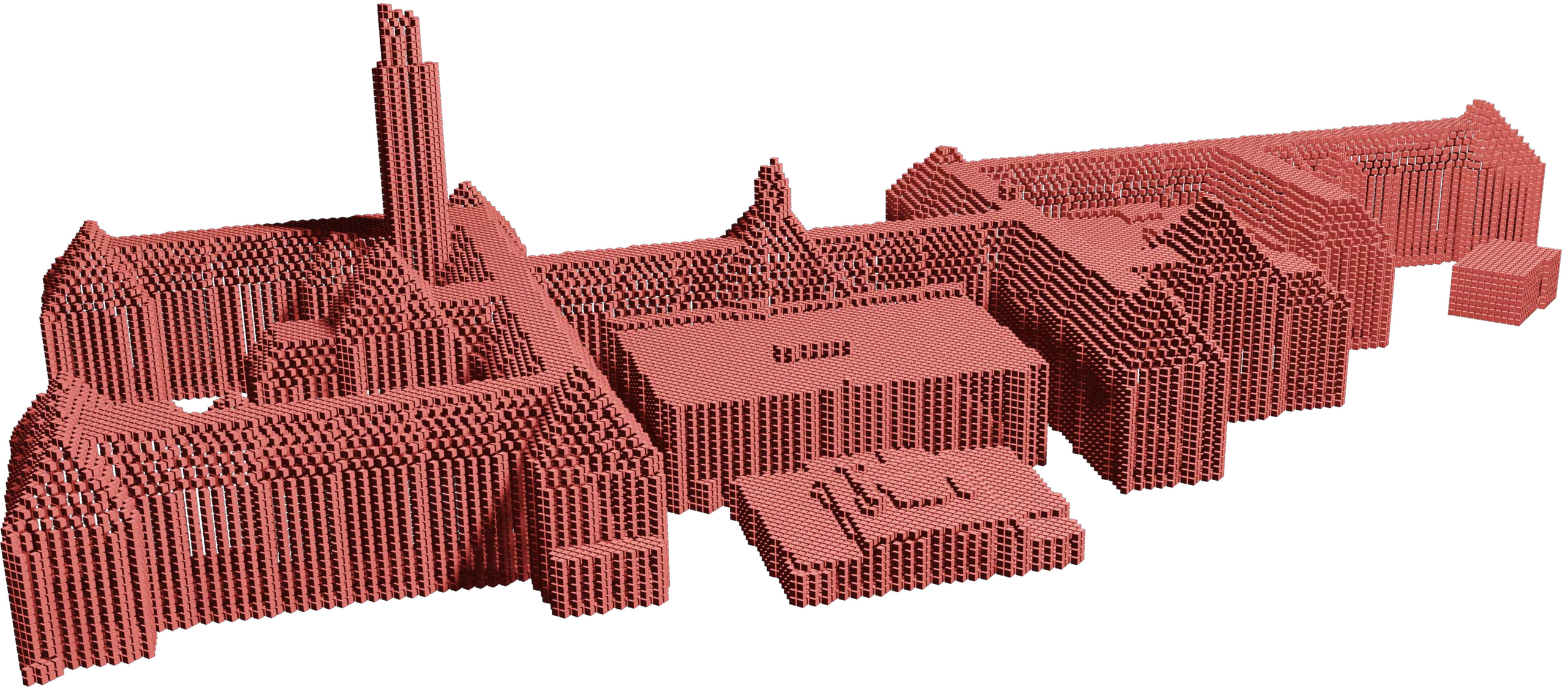
Image: pygis.io



Computer representations: objects as vector and raster



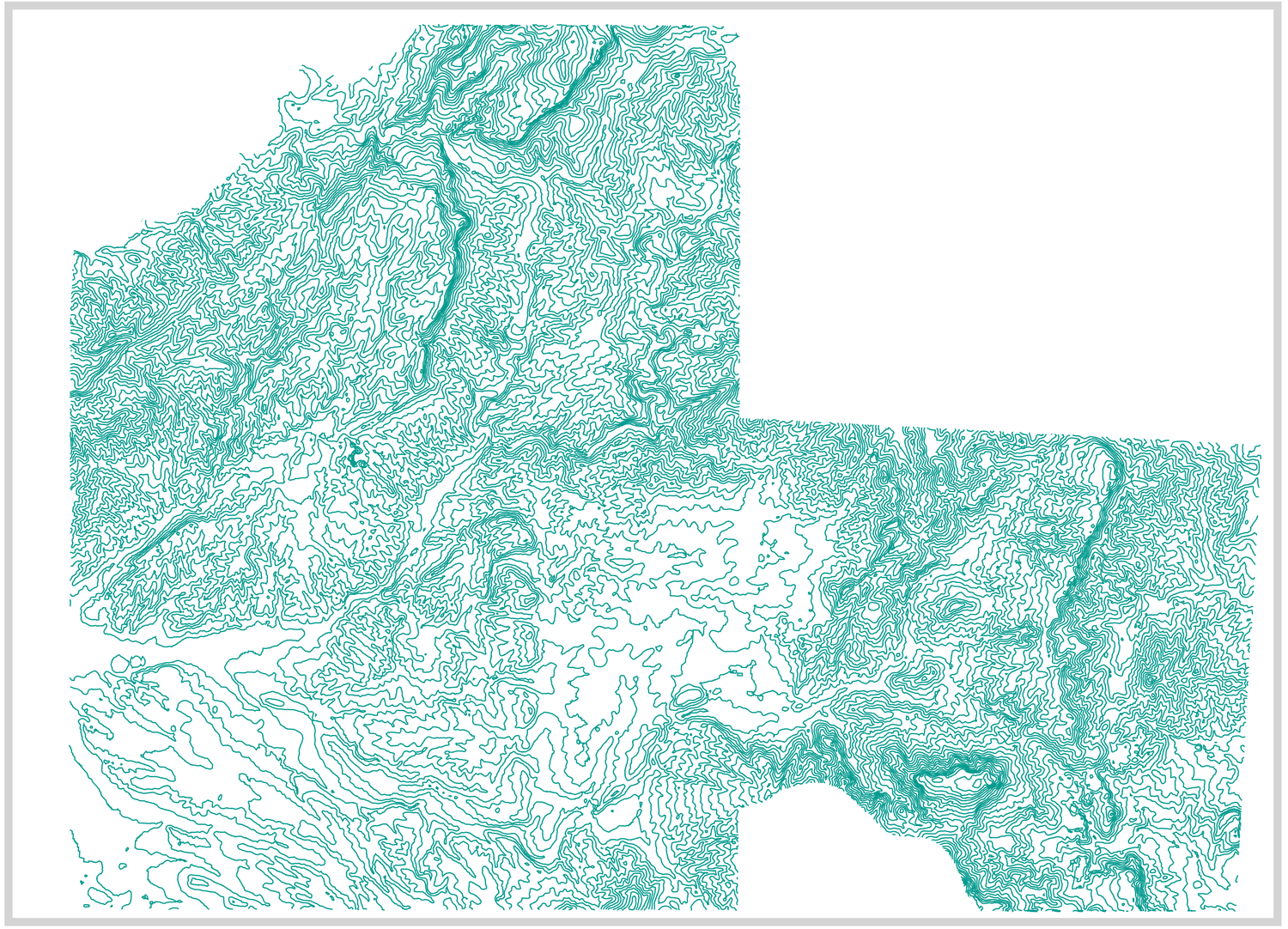
Computer representations: object as raster



Computer representations: object as raster



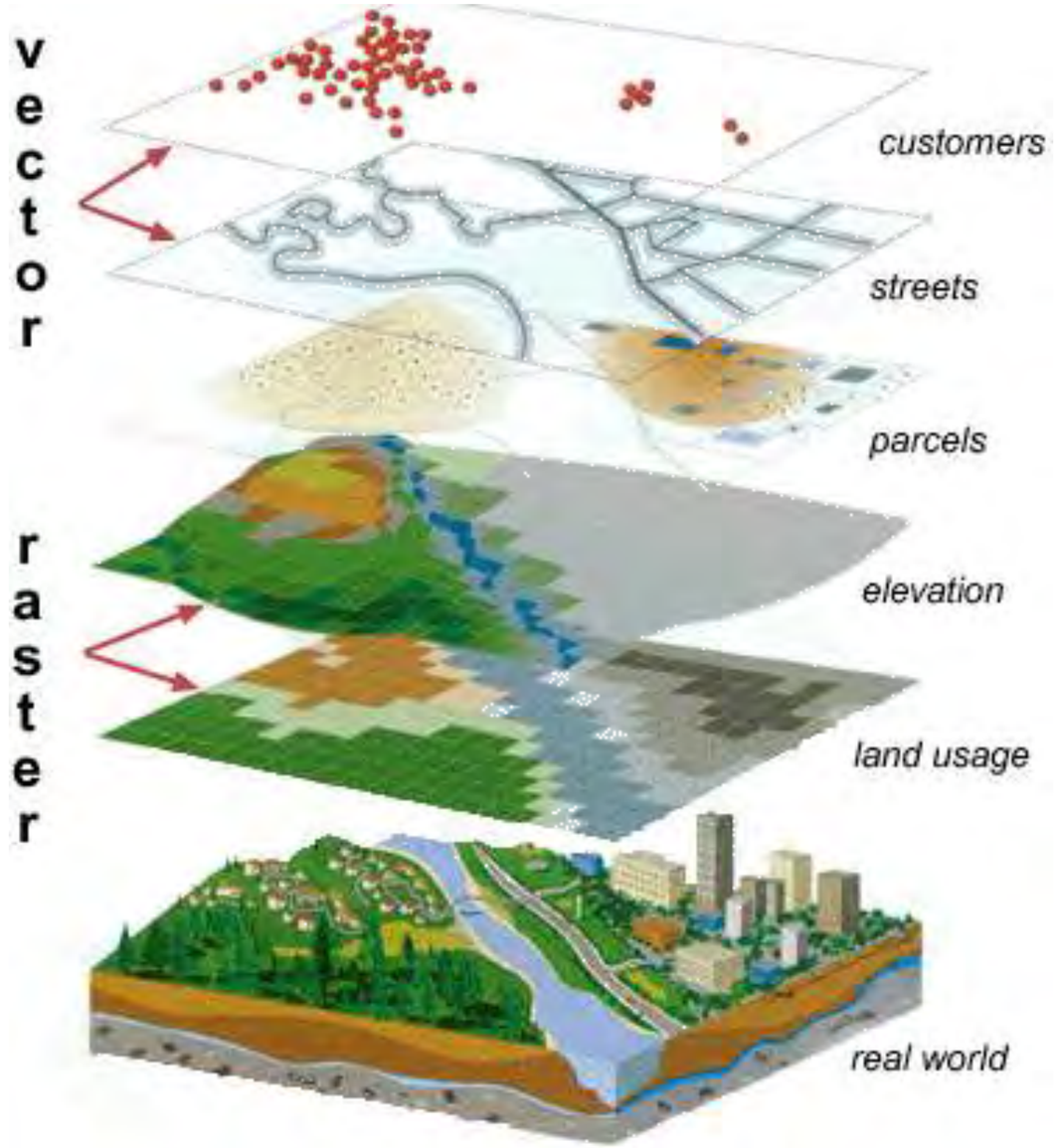
Computer representations: field as vector



Computer representations: vector and raster

Raster representation	*Vector representation*
advantages	
• simple data structure • simple implementation of overlays • efficient for image processing	• efficient representation of topology • adapts well to scale changes • allows representing networks • allows easy association with attribute data
disadvantages	
• less compact data structure • difficulties in representing topology • cell boundaries independent of feature boundaries	• complex data structure • overlay more difficult to implement • inefficient for image processing • more update-intensive

Computer representations: vector and raster



Computer representations: geodata

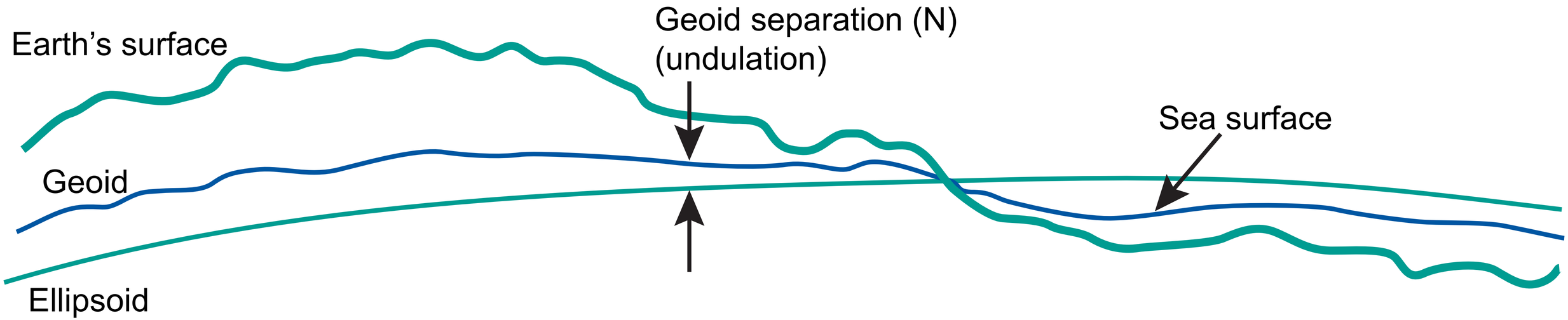
- Raster: GeoTIFF (.tif, .tiff), JPEG2000 (.jp2, .j2k), ERDAS Imagine (.img), Esri Grid, NetCDF (.nc), HDF (.hdf, .h5), ASCII grid (.asc, .dem), Cloud-optimised GeoTIFF (COG), MrSID (.sid), other image formats with World File (e.g. PNG or BMP), etc.

- Vector: Shapefile (.shp + others), GeoJSON (.geojson, .json), GeoPackage (.gpkg), KML/KMZ (.kml, .kmz), GML (.gml), Esri geodatabase (.gdb), OpenStreetMap (.osm, .pbf), SpatiaLite (.sqlite), CityJSON (.city.json), text-based formats with WKT geometry (e.g. CSV), etc.

Foundations of 2D and 3D GIS contents

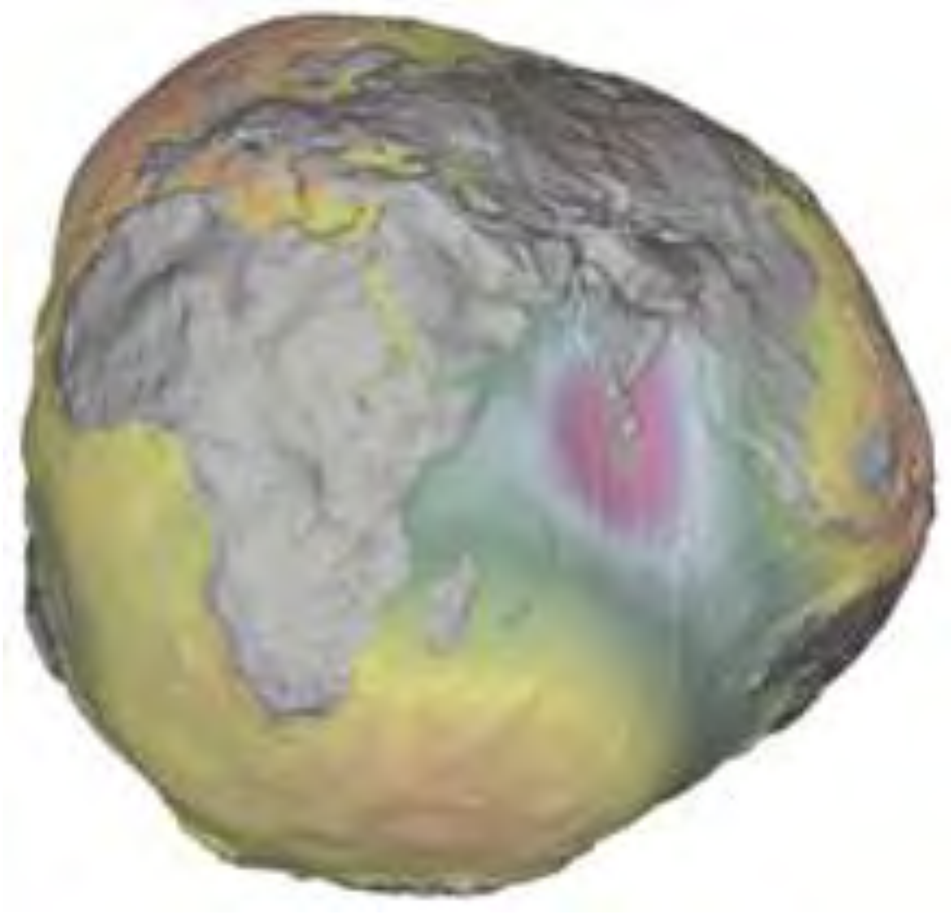
- Why a GIS? What is a GIS?
- Geographic phenomena: fields and objects
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- Georeferencing
- QGIS demo & practical session

Georeferencing: Earth’s surface, geoid and ellipsoid



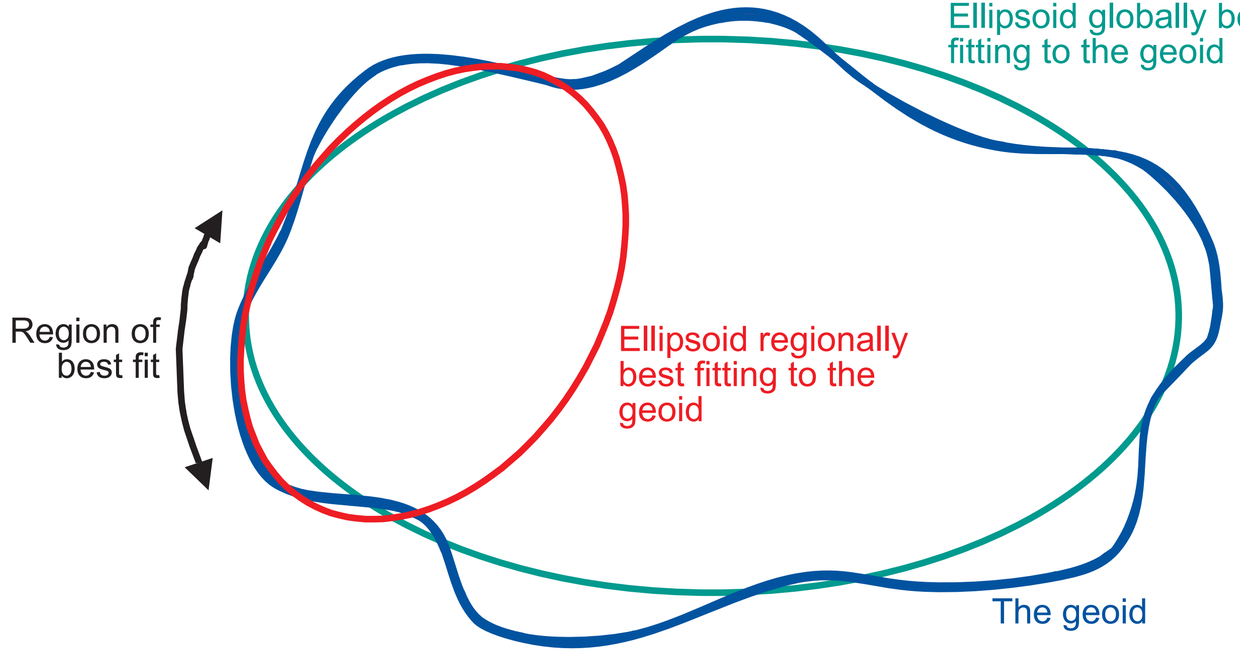
Georeferencing: geoid

- **Geoid**: equipotential surface of the Earth, i.e. shape of the Earth's sea level without tides, currents or wind if water could freely pass through continents. Typically used for *heights*.

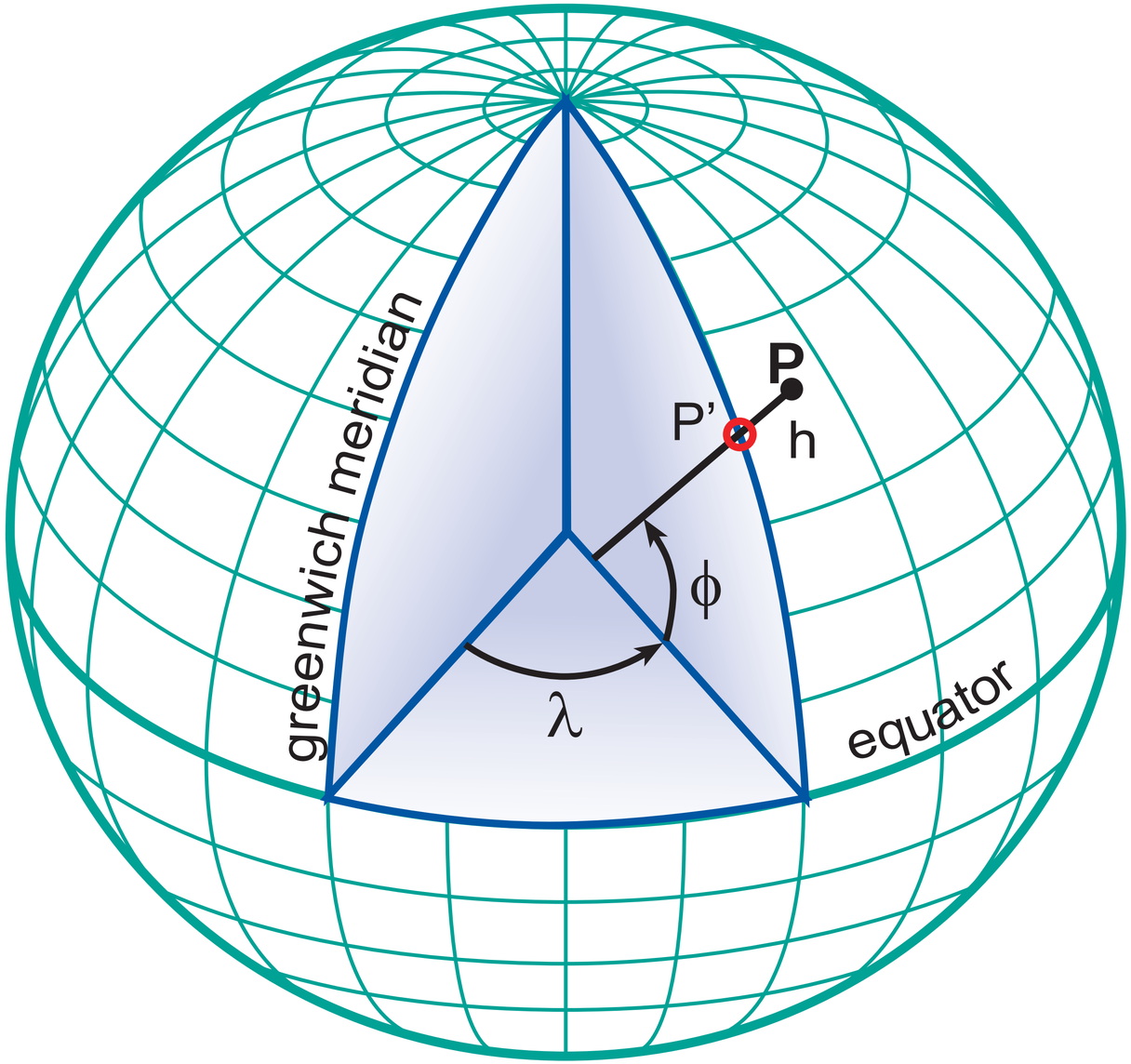


Georeferencing: ellipsoid

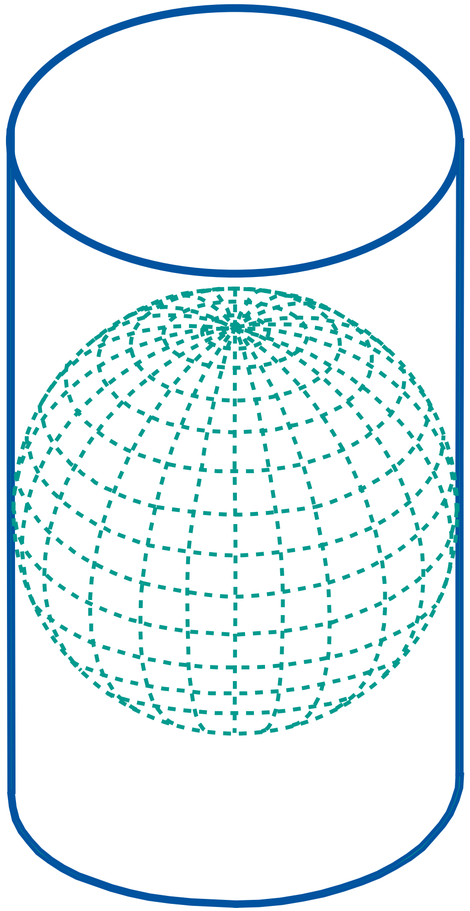
- **Ellipsoid**: most convenient mathematical object that resembles (part of) the geoid with reasonable accuracy. Typically used for *horizontal coordinates*.



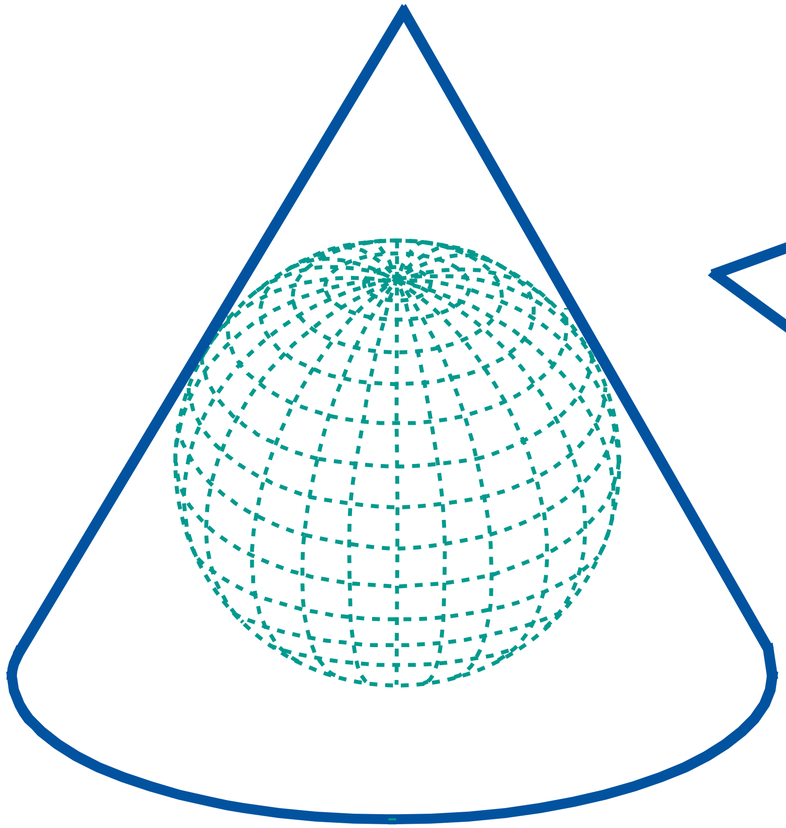
Georeferencing: 3D geographic coordinates



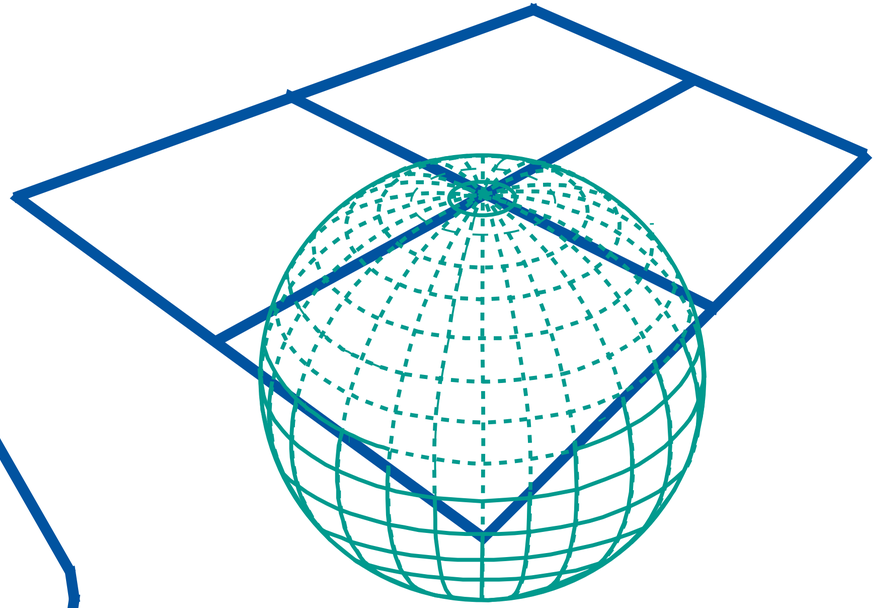
Georeferencing: from an ellipsoid to a surface



Cylindrical

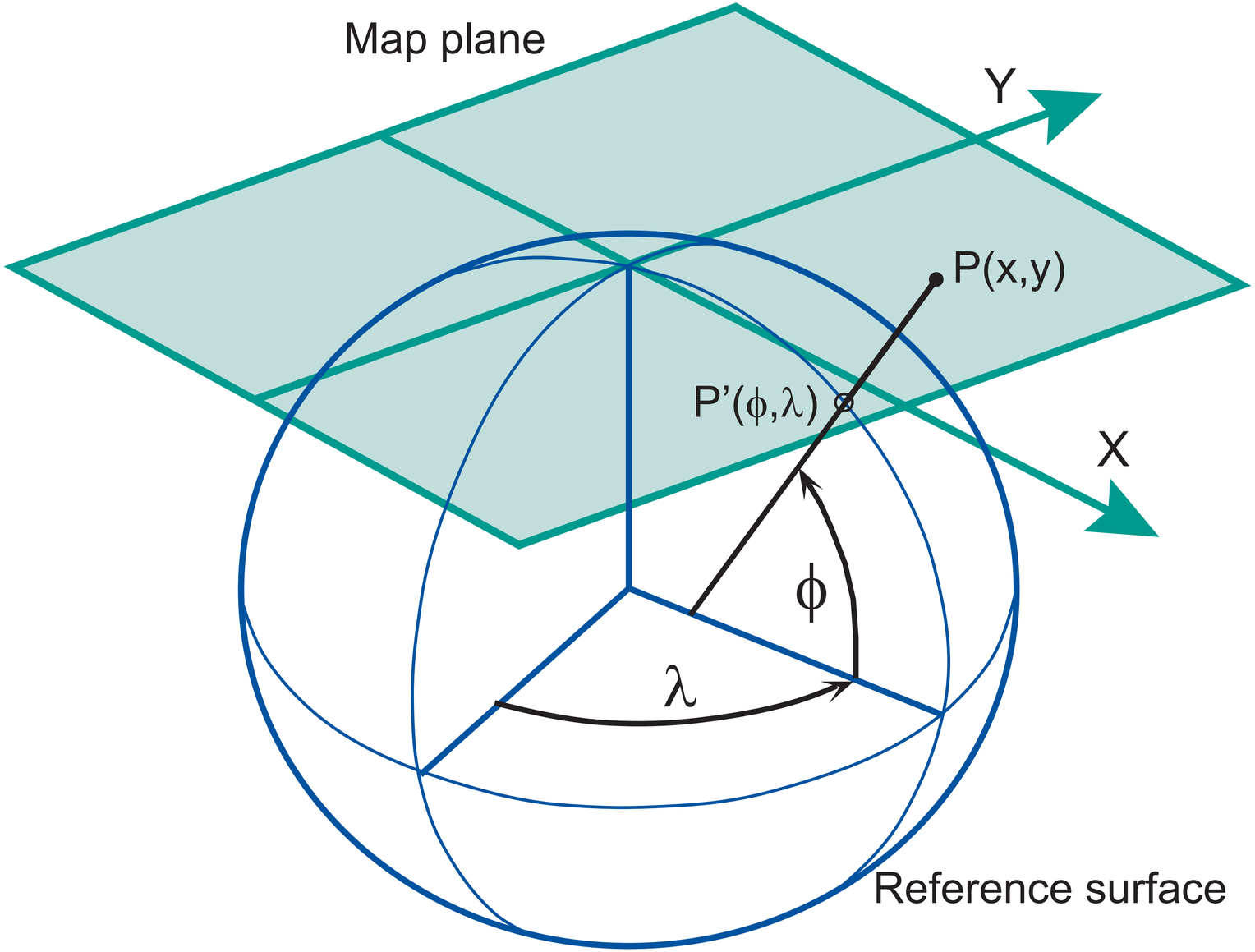


Conical

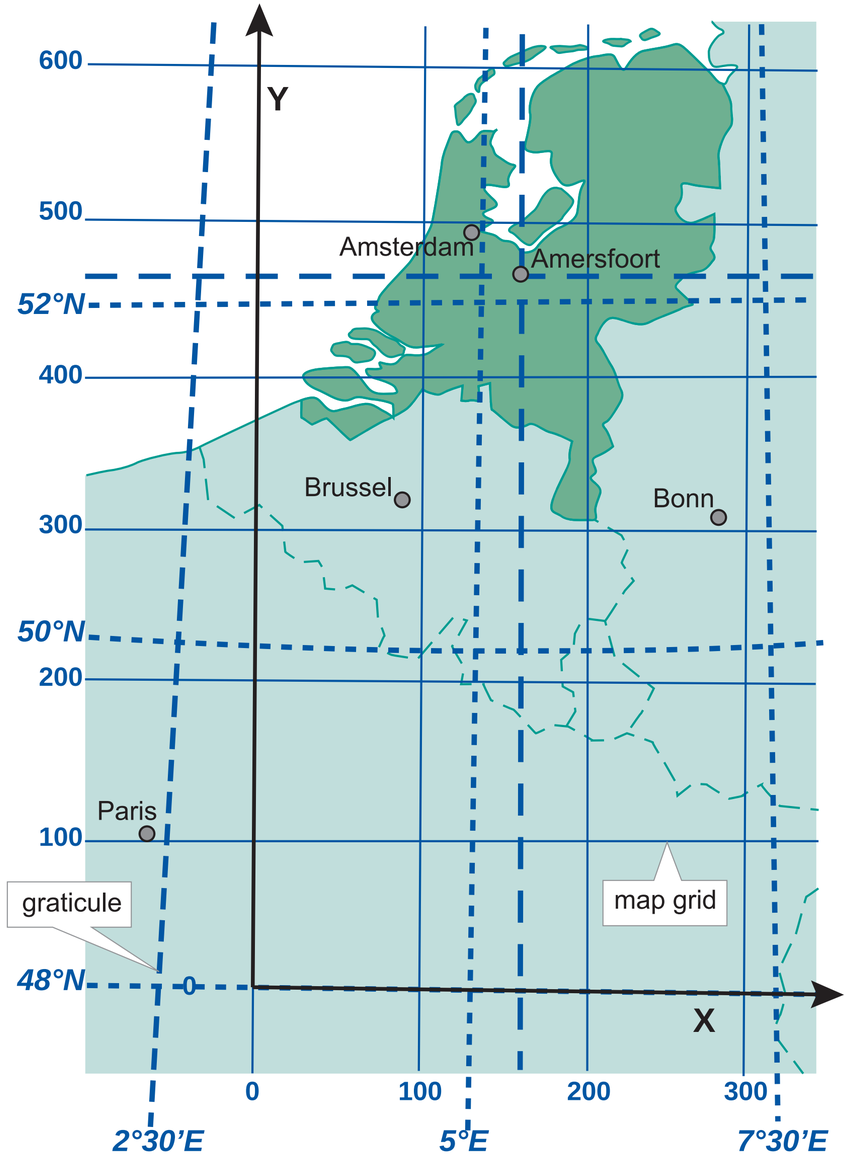


Azimuthal

Georeferencing: from 3D geographic to Cartesian coordinates



Georeferencing: from 3D geographic to Cartesian coordinates



Georeferencing: EPSG

- Many parameters to store: ellipsoid (semi-major axis, semi-minor axis, Equatorial plane, prime meridian), projection surface, units, etc.

- Collectively known as a *geodetic datum*.

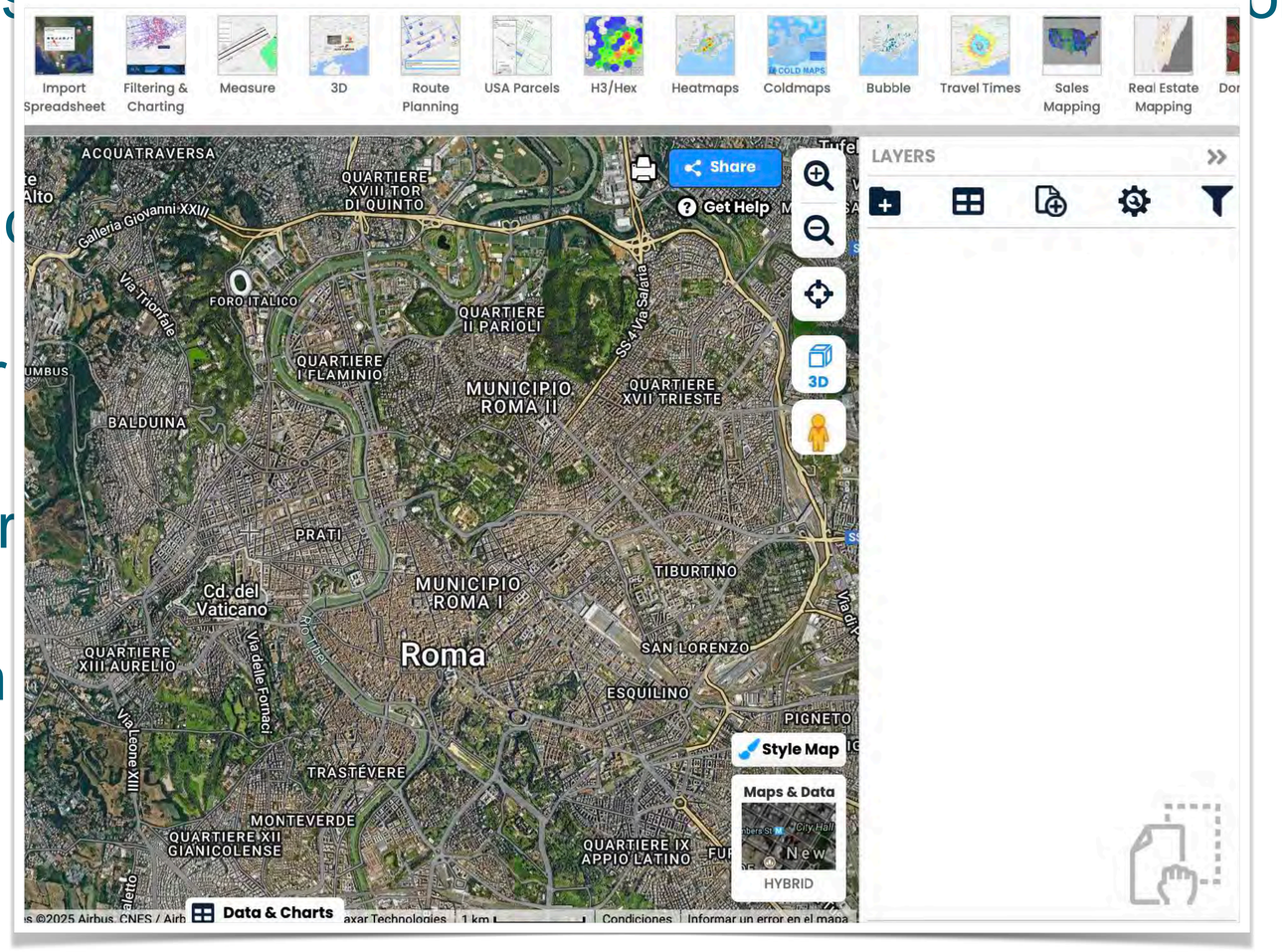
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    UNIT["degree",0.017453292519943 3,
        AUTHORITY["EPSG","9122"]],
    AUTHORITY["EPSG","4326"]]
```

Georeferencing: EPSG

- All parameters can be stored conveniently using an EPSG code. Some examples:
  - 4326: WGS84 (latitude and longitude in GPS)
  - 3857: Web Mercator for WGS84 (most web maps)
  - 3035: ETRS89 (EU-recommended standard for Europe)
  - 4269: NAD83 (North America)
- Check: epsg.io

Georeferencing: EPSG

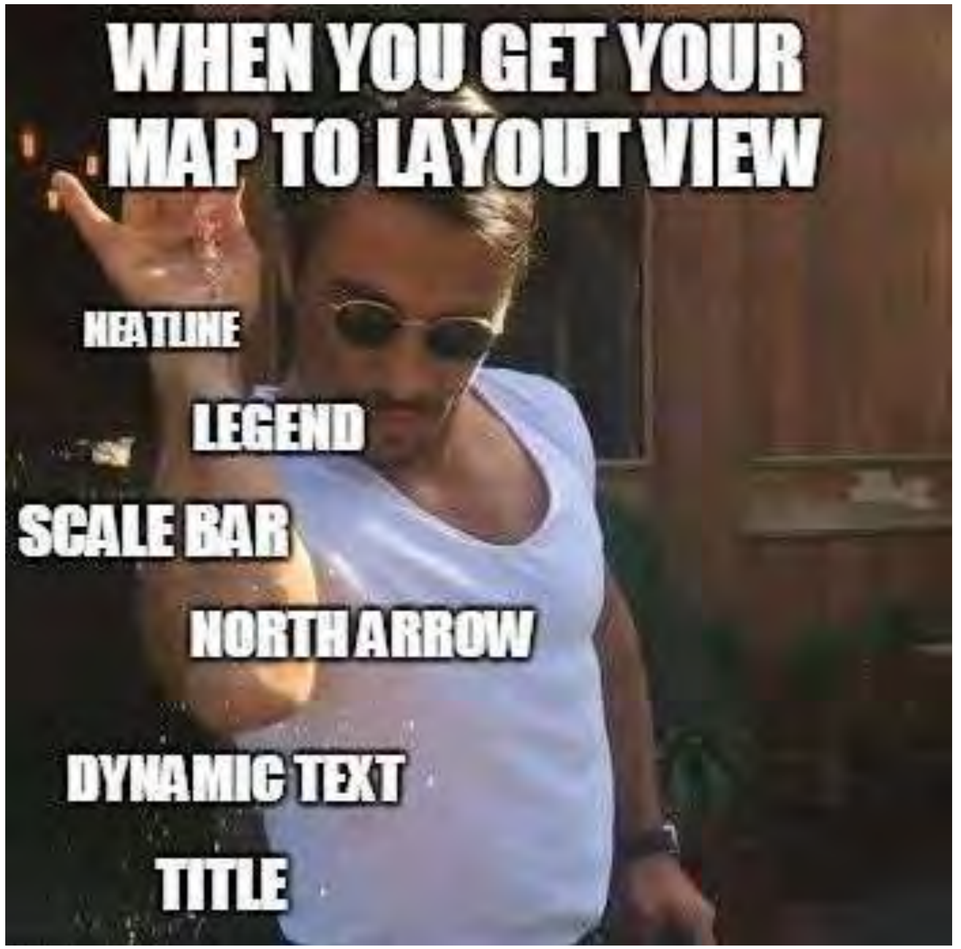
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  - 4326: WGS84 (latitu
  - 3857: Web Mercator
  - 3035: ETRS89 (EU-r
  - 4269: NAD83 (North
- Check: epsg.io



Questions?

Foundations of 2D and 3D GIS contents

- Why a GIS? What is a GIS?
- Geographic phenomena: fields and objects
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- Georeferencing
- QGIS demo & practical session



Time for a QGIS demo!

Practical session 1

- Create a map of a region of your interest (e.g. your hometown or a place where you want to travel to). Show some of its interesting features :-).
- Use 2-3 datasets. Some ideas: cities, land use, elevation, hydrology, roads.
- Some ideas for Portugal: dados.gov.pt or individual websites of Direção-Geral do Território (DGT), Instituto Nacional de Estatística (INE), SNIG (Sistema Nacional de Informação Geográfica), etc.
- Use a nice colour scheme, readable symbols, etc.

Module 5 contents

- Foundations of 2D and 3D GIS
- Processing 2D and 3D geodata
- 3D city models

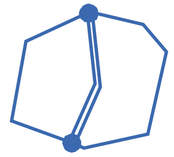
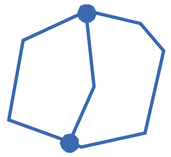
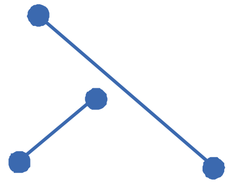
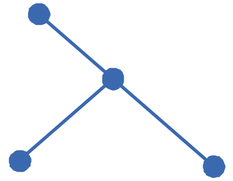
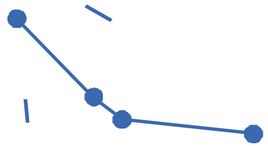
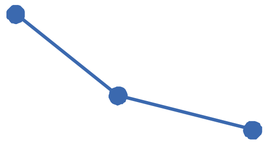
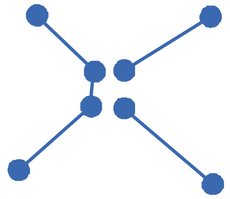
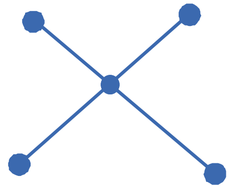
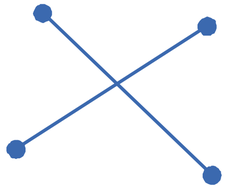
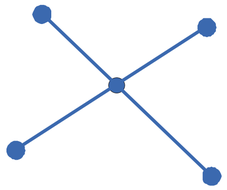
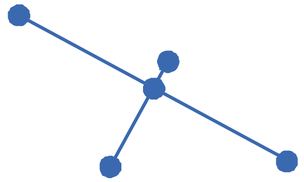
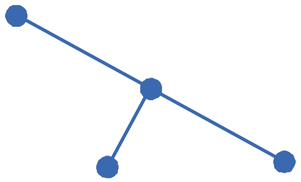
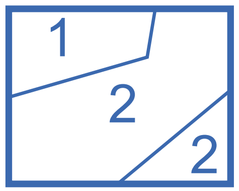
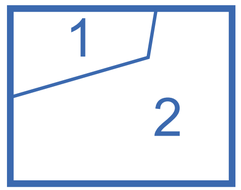
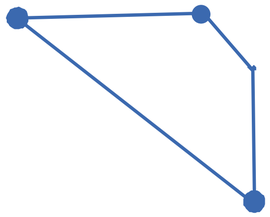
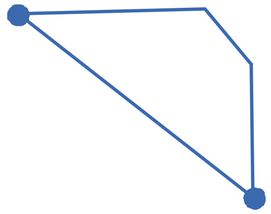
Processing 2D and 3D geodata contents

- Data preparation
- Spatial analysis
- Practical session

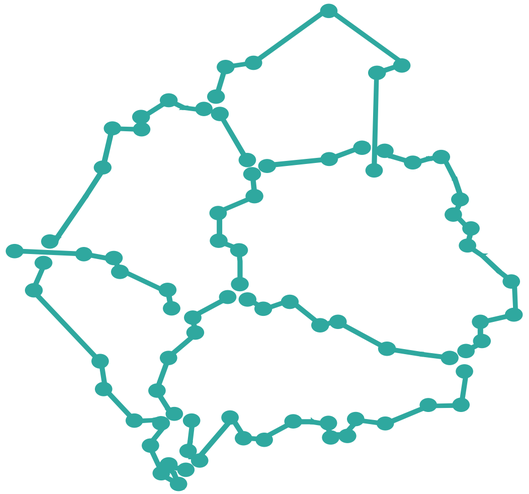


Image: Freepik

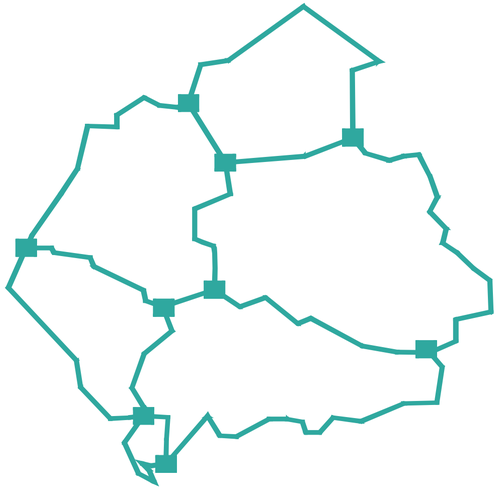
Data preparation: cleanup

Before cleanup	After cleanup	Description	Before cleanup	After cleanup	Description
		Erase duplicates or sliver lines			Extend undershoots
		Erase short objects			Snap clustered nodes
		Break crossing objects			Erase dangling objects or overshoots
		Dissolve polygons			Dissolve nodes into vertices

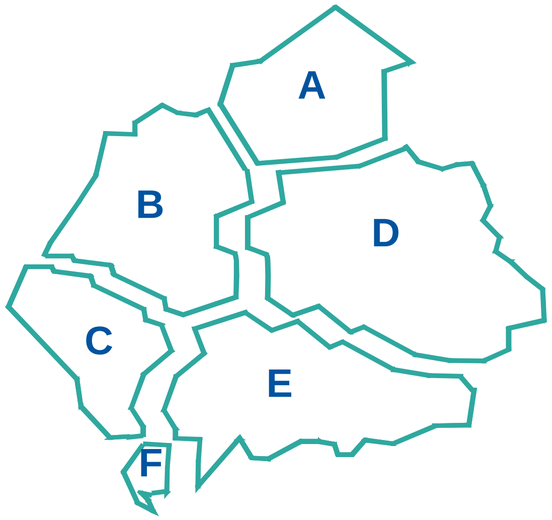
Data preparation: typical workflow



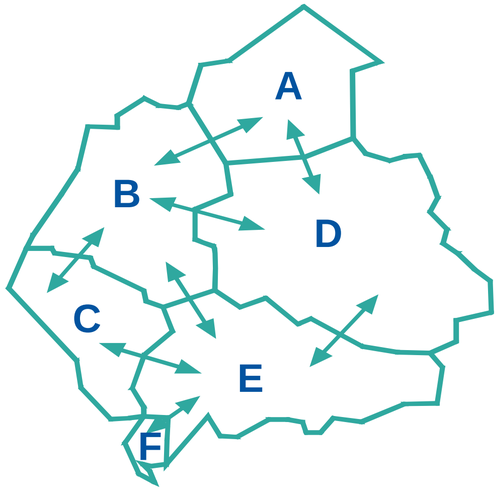
(a) Spaghetti data



(b) Spaghetti data (cleaned)

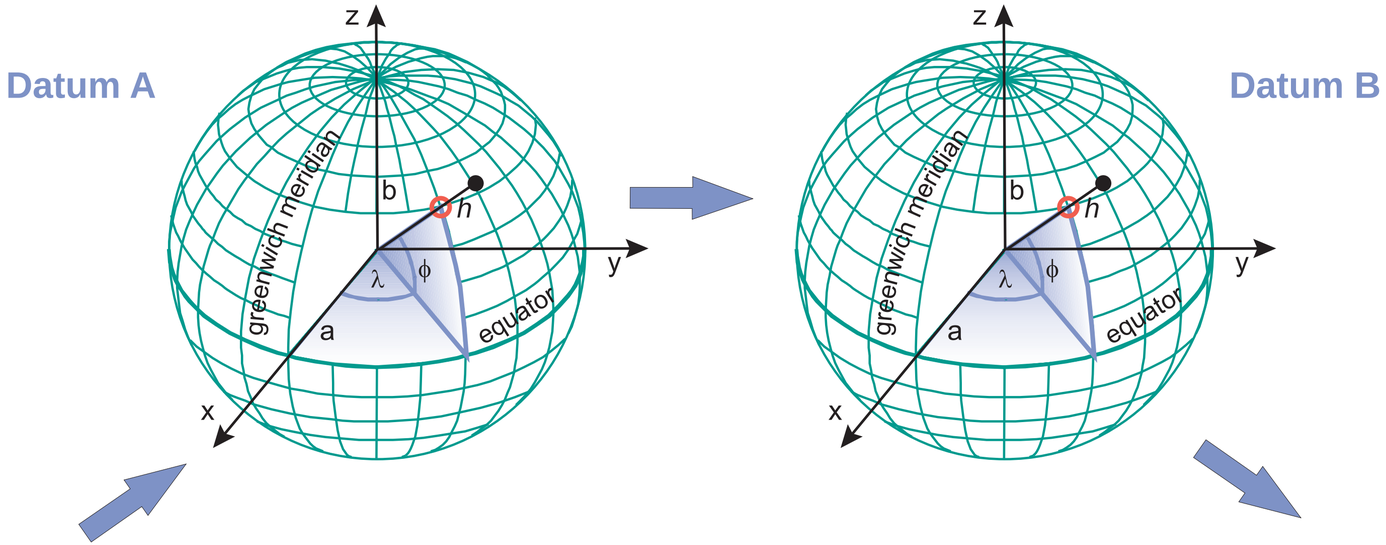


(c) Polygons



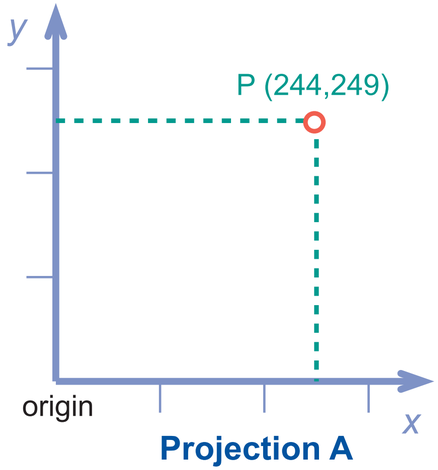
(d) Topology

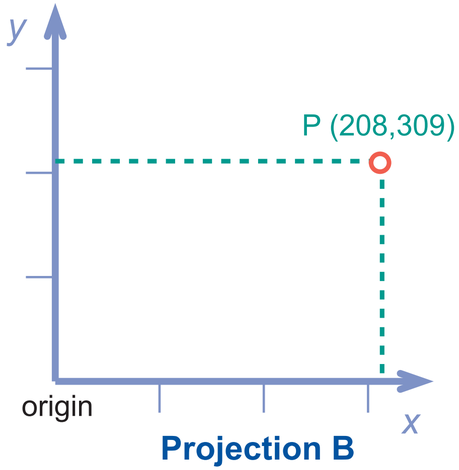
Data preparation: reprojection



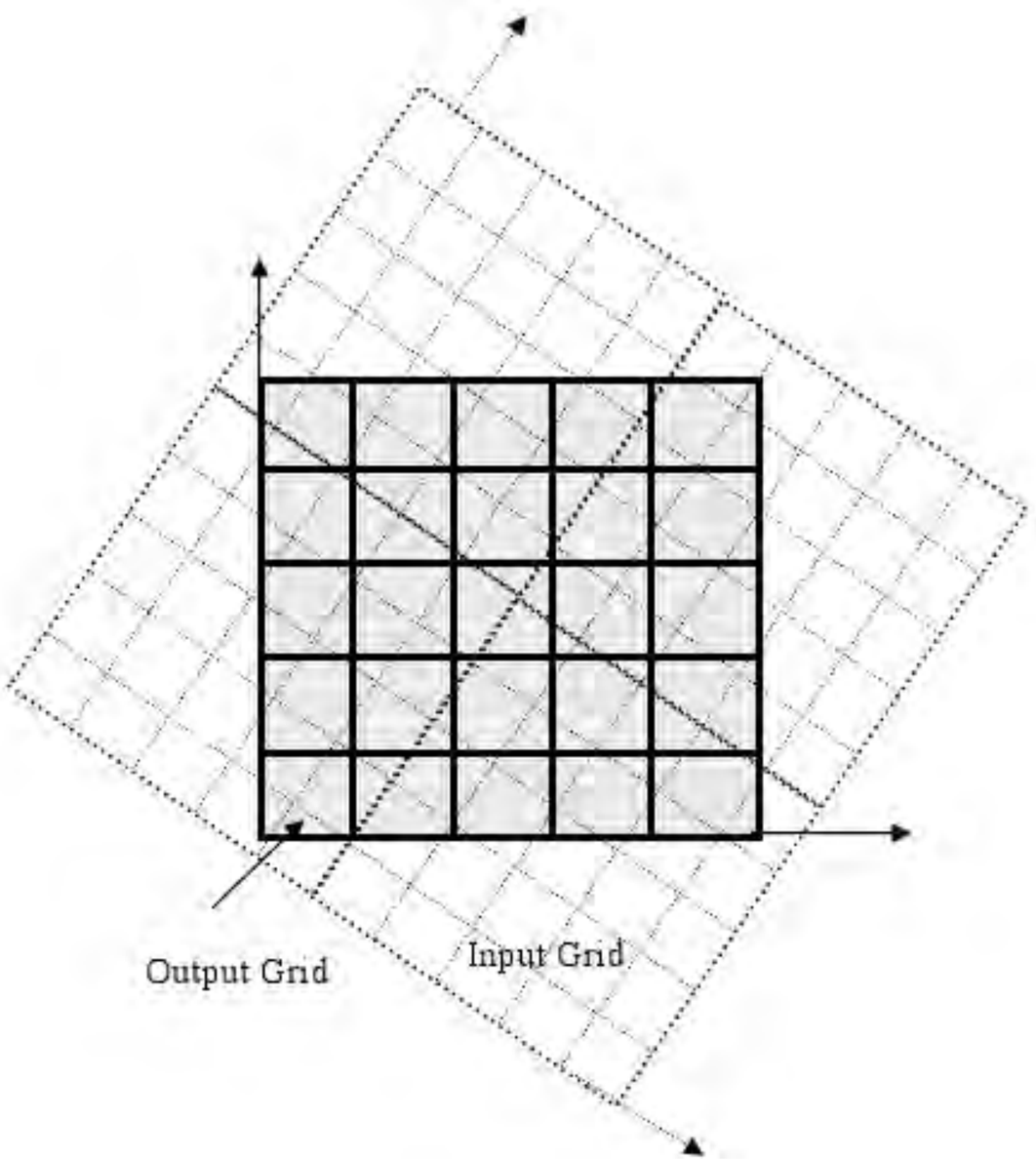
Cartesian reference coordinate system I

Cartesian reference coordinate system II

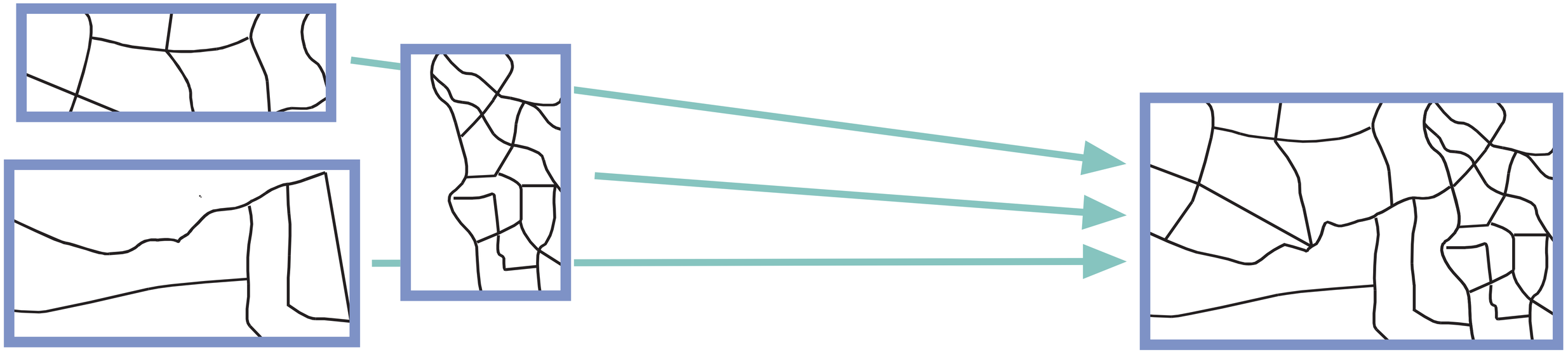




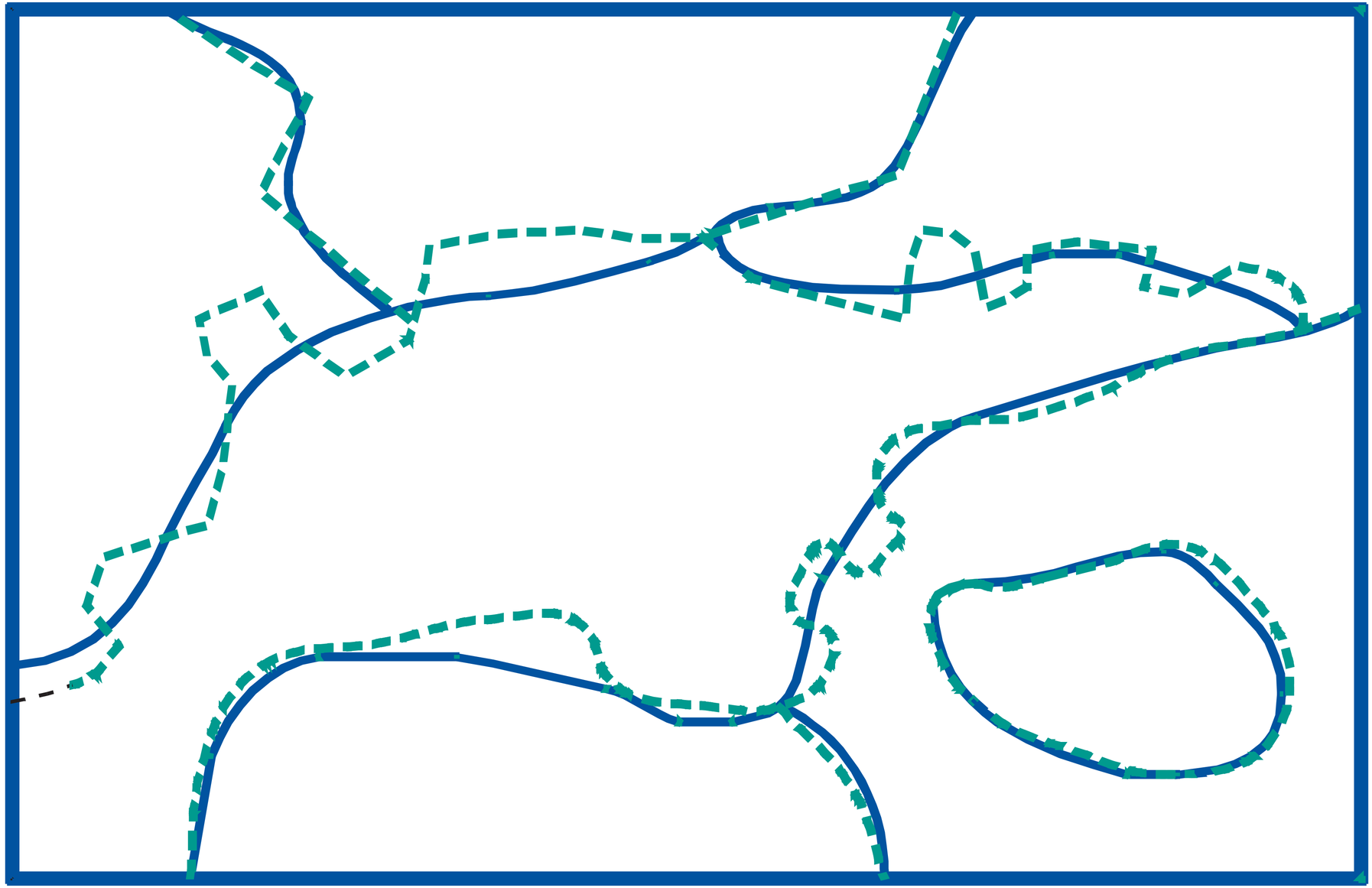
Data preparation: raster resampling



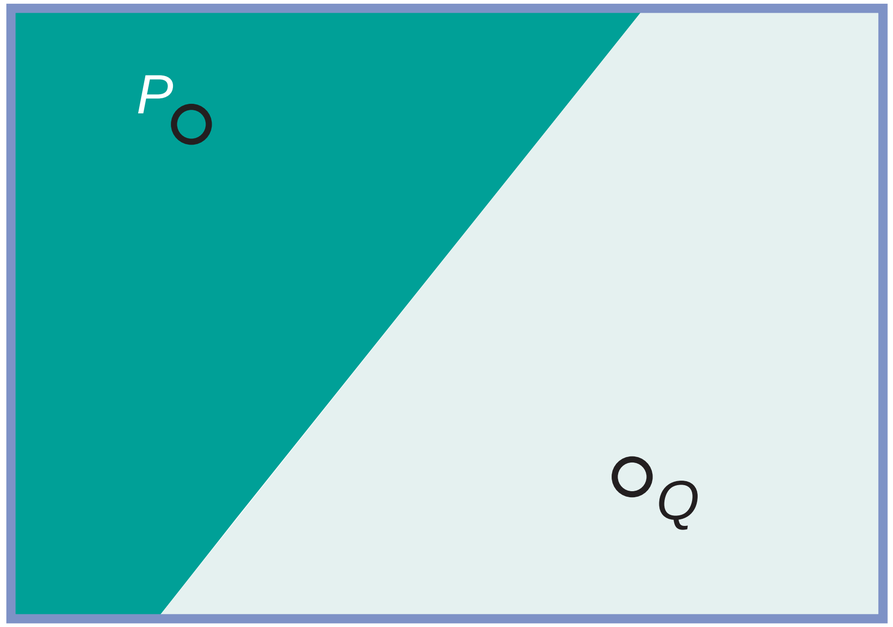
Data preparation: combining datasets

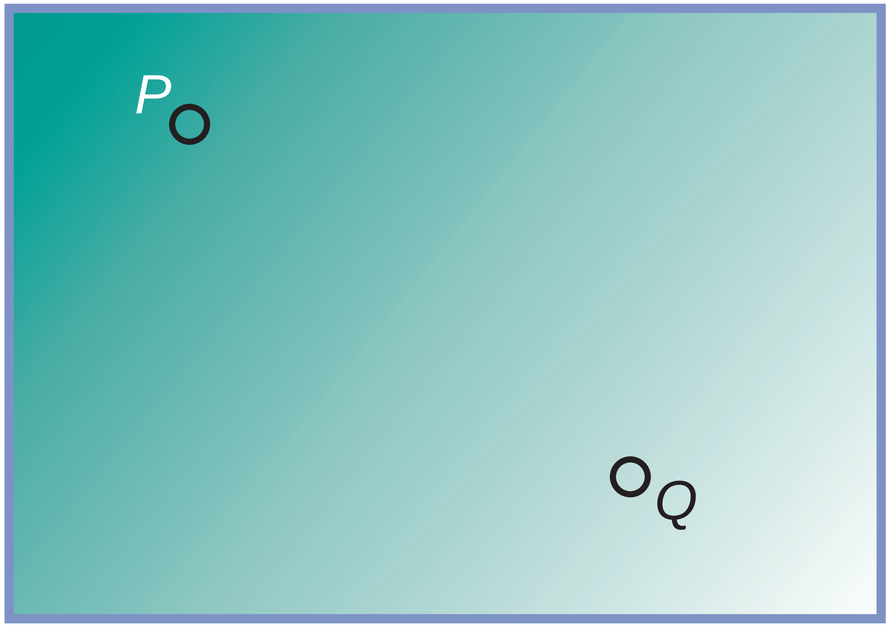


Data preparation: combining datasets

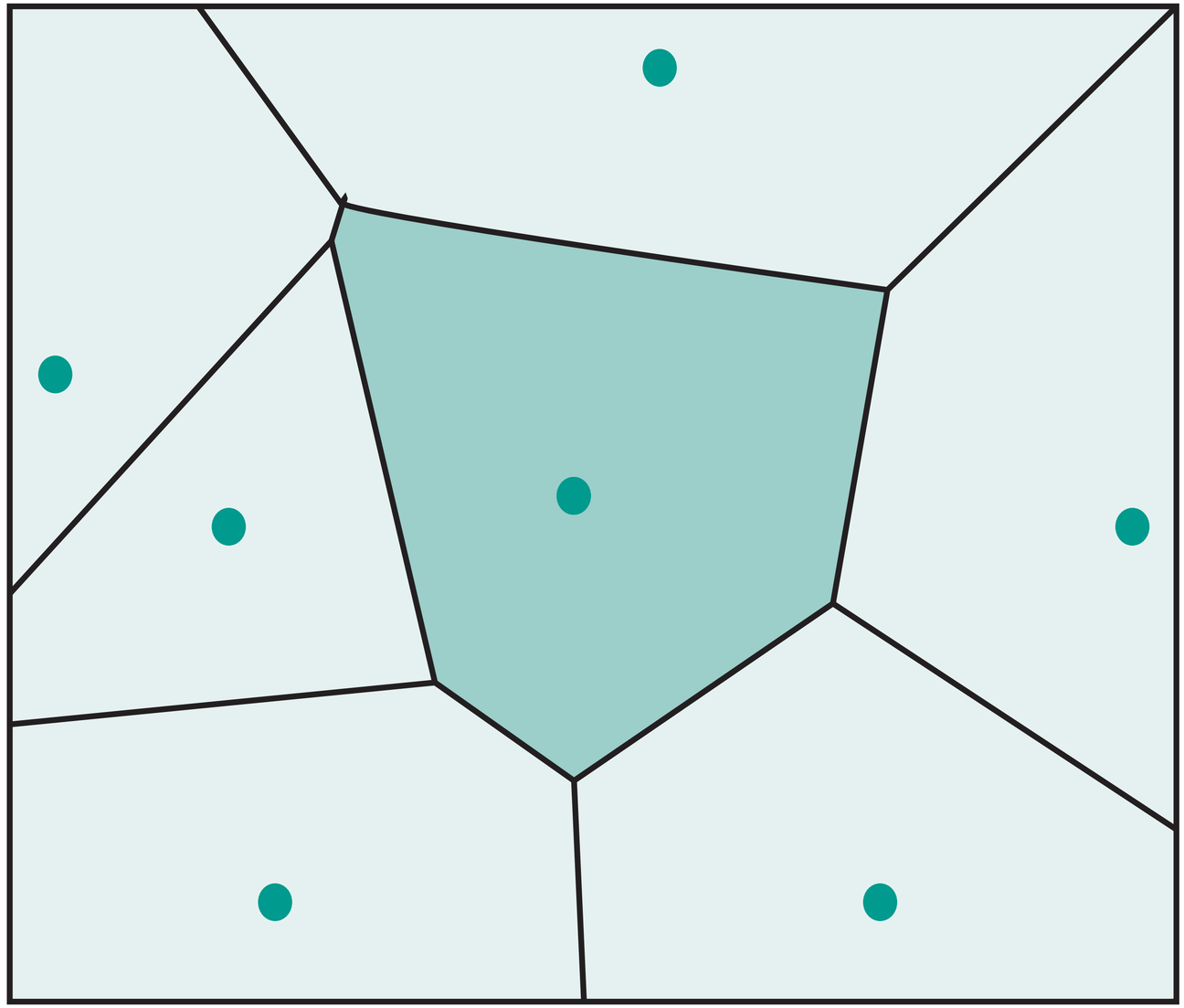


Data preparation: interpolation from points

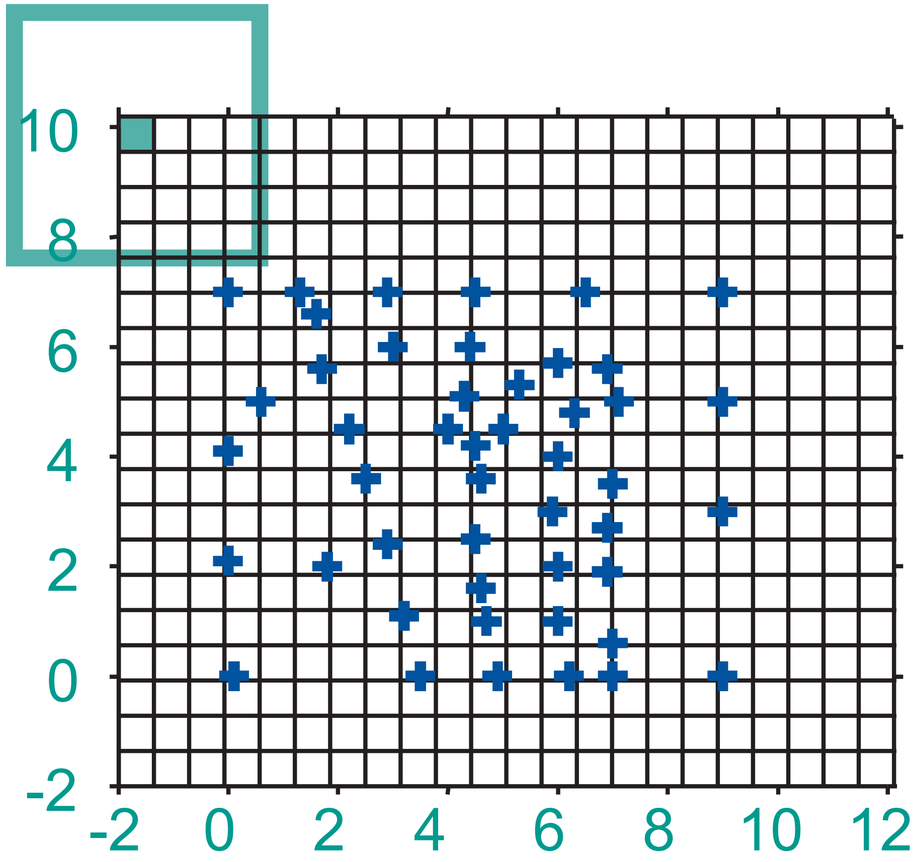


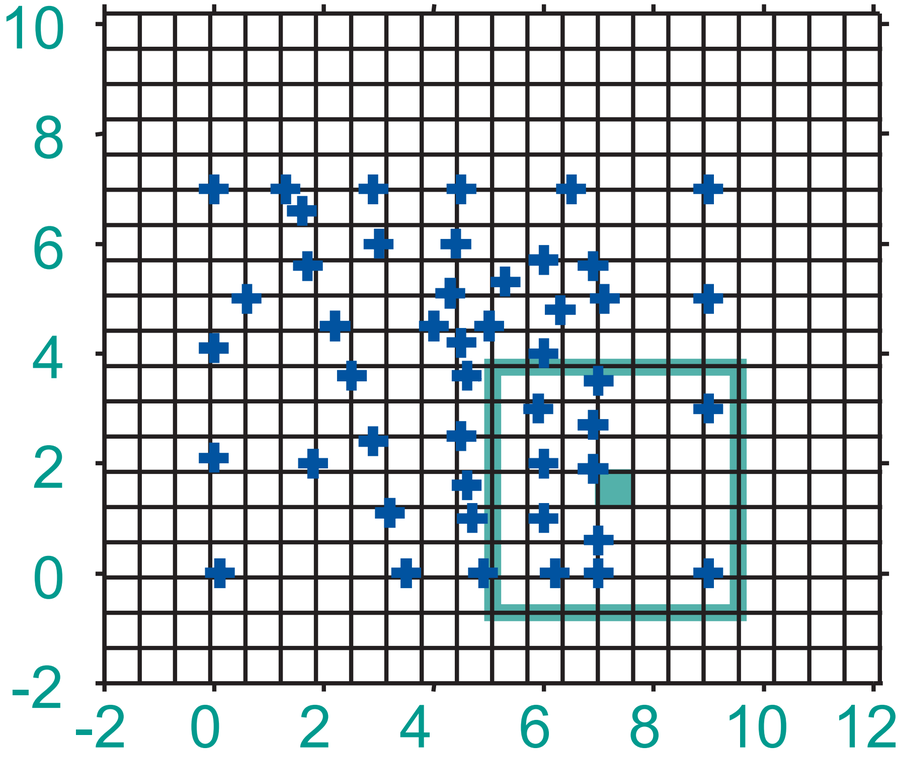


Data preparation: interpolation from points

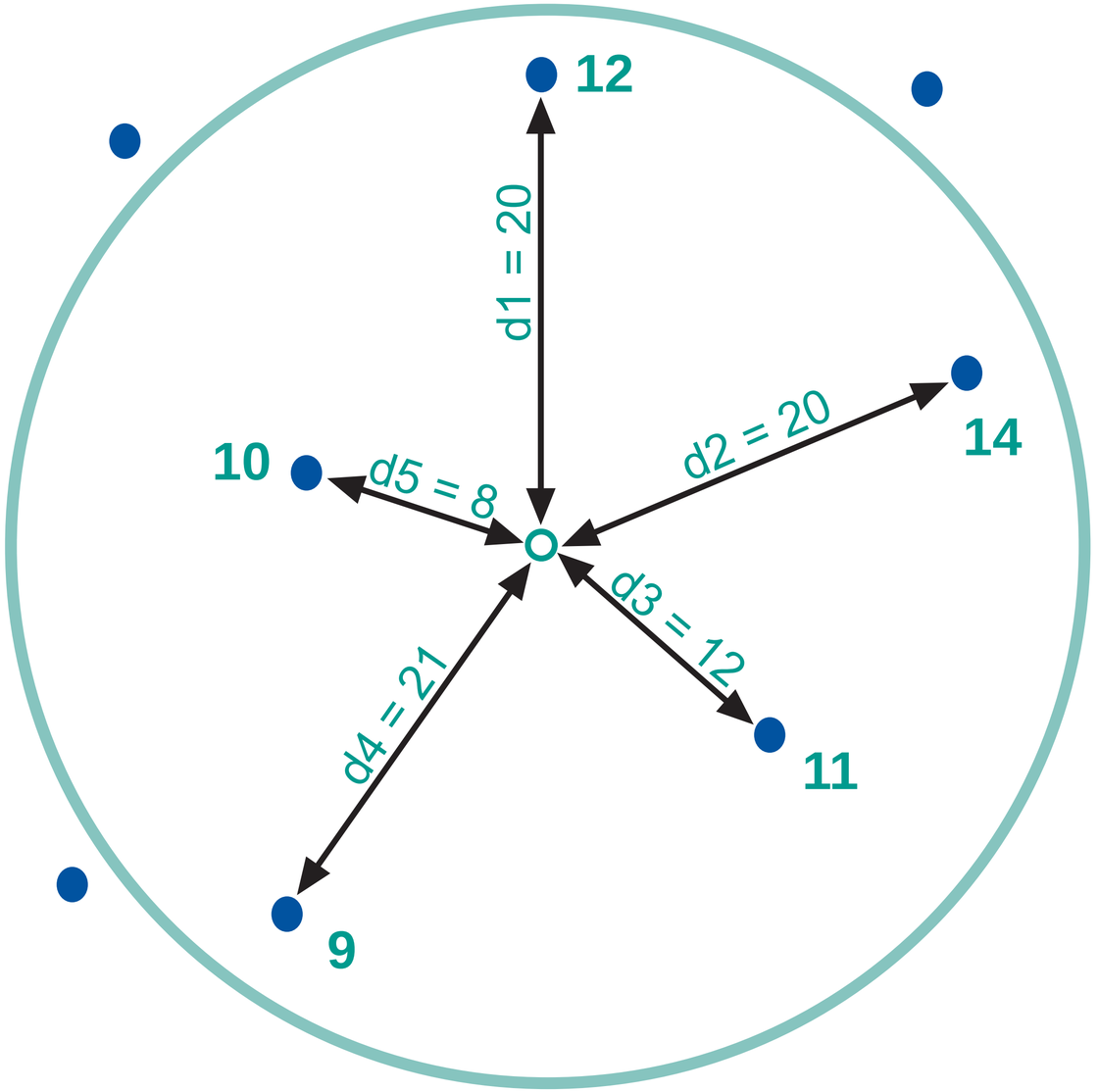


Data preparation: interpolation from points





Data preparation: interpolation from points



Processing 2D and 3D geodata contents

- Data preparation
- Spatial analysis
- Practical session

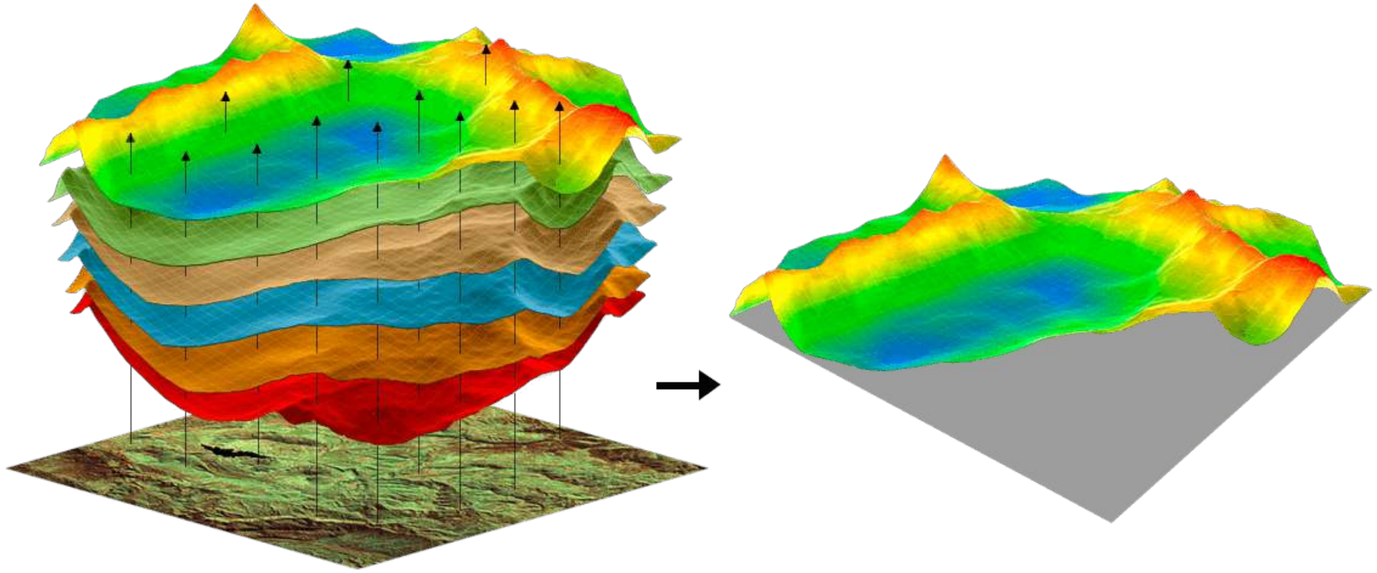


Image: EOS Data Analytics

Spatial analysis

Using one layer:

- classification
- retrieval
- generalisation
- measurement

Using multiple layers:

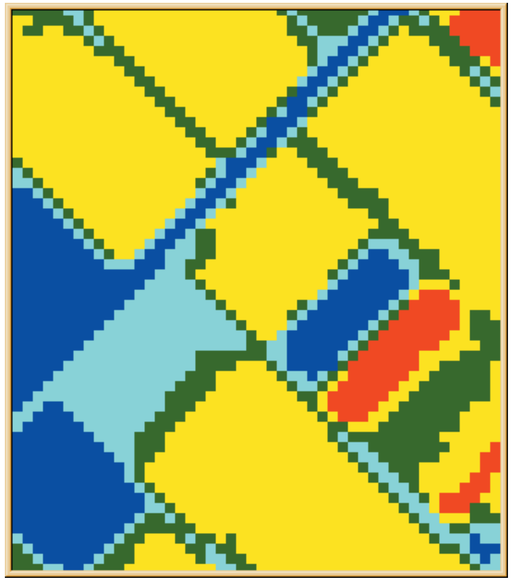
- overlays
- neighbourhood
- connectivity

Spatial analysis: classification

- **Classification** allows the assignment of features to a class on the basis of attribute values or attribute ranges (definition of data patterns).

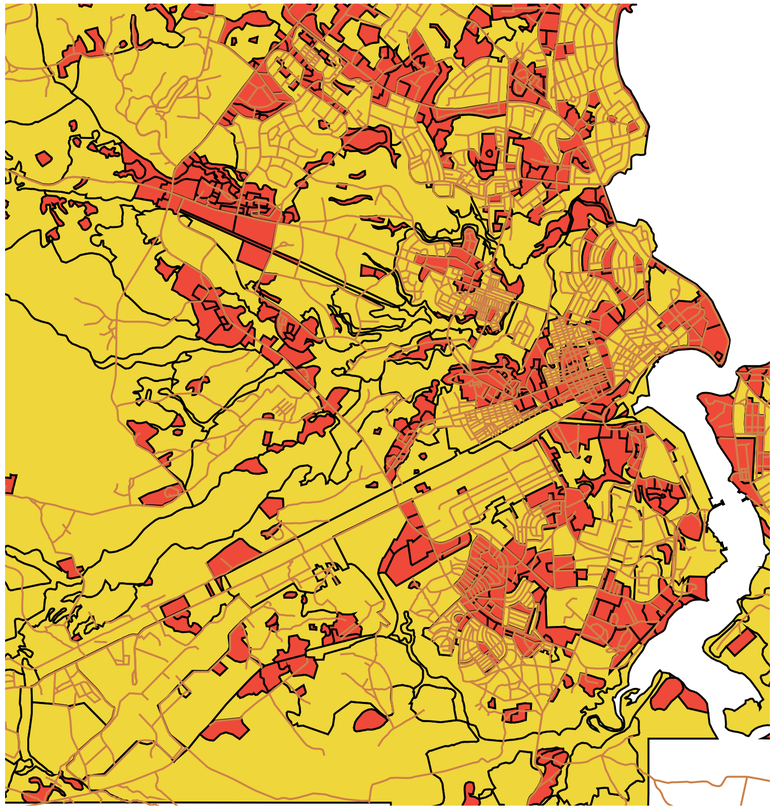
- Example: on the basis of reflectance characteristics found in a raster, pixels may be classified as representing different crops, such as potato and maize.





Spatial analysis: retrieval

- **Retrieval** functions allow the selective search of data
- Example: select all polygons where Area < 400 000.

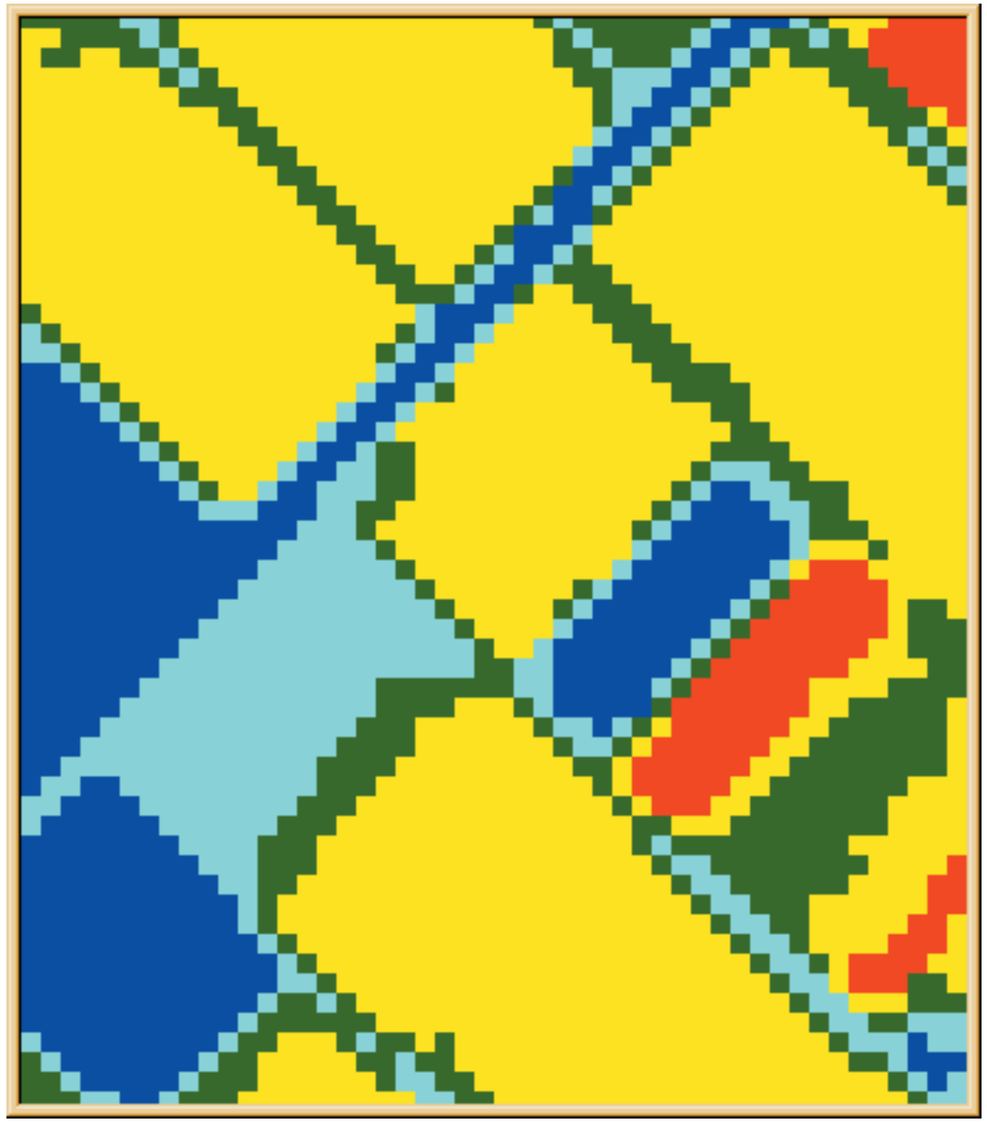


Area	IDs	LandUse
174308.70	2	30
2066475.00	3	70
214582.50	4	80
29313.86	5	80
73328.08	6	80
53303.30	7	80
614530.10	8	20
1637161.00	9	80
156357.40	10	70
59202.20	11	20
83289.59	12	80
225642.20	13	20
28377.33	14	40
228930.30	15	30
986242.30	16	70

Spatial analysis: generalisation

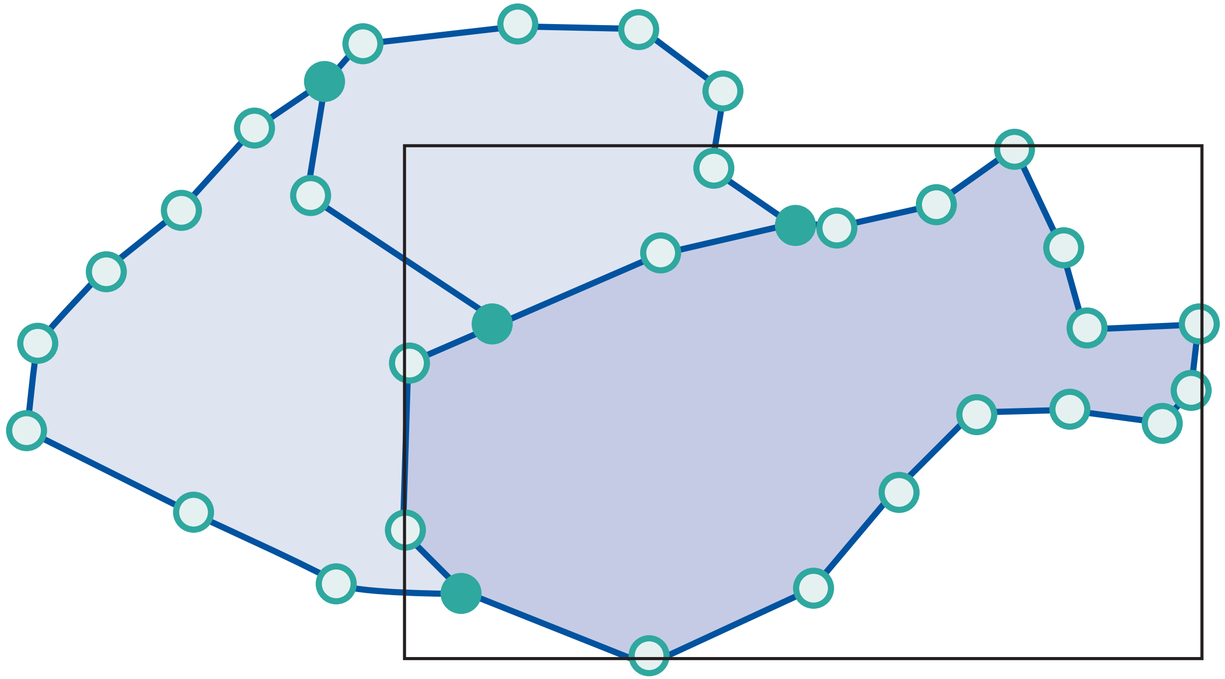
- **Generalisation** is a function that joins different classes of objects with common characteristics to a higher level (generalised) class

- Example: generalise fields where potato or maize are grown as ‘food production fields’.



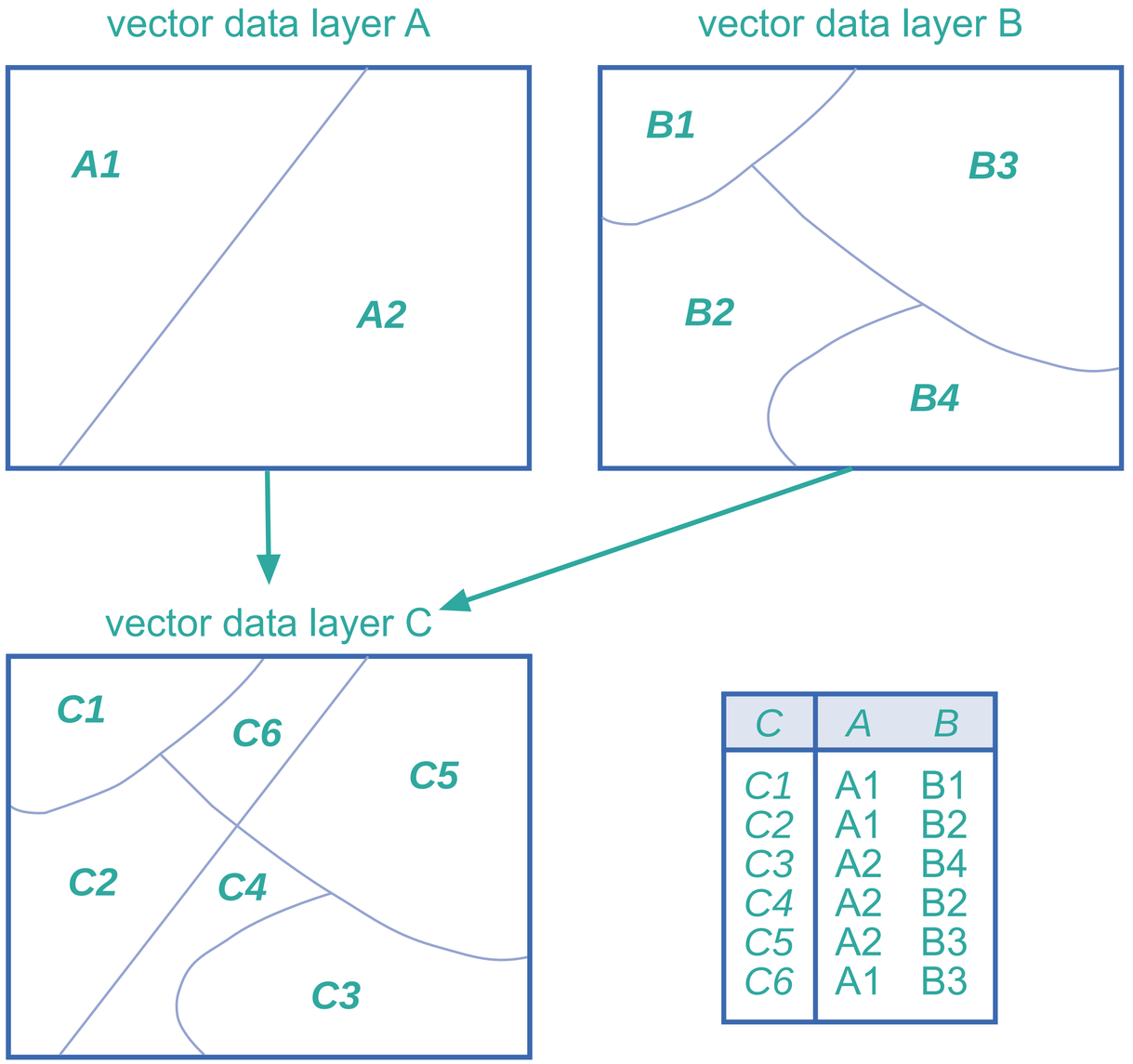
Spatial analysis: measurement

- **Measurement** functions allow the calculation of distances, lengths, or areas.
- Example: obtain the minimal bounding box of a polygon.



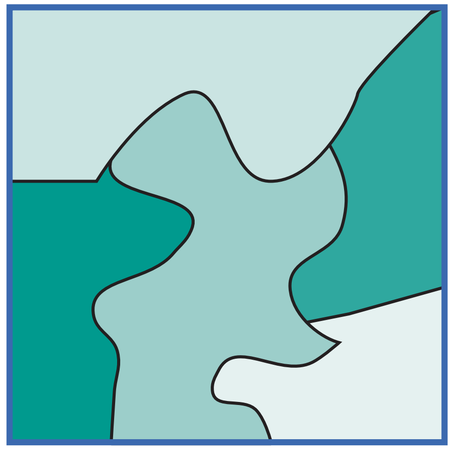
Spatial analysis: overlay

- **Overlays** allow the combination of two (or more) spatial data layers comparing them position by position, and treating areas of overlap—and of non-overlap—in distinct ways

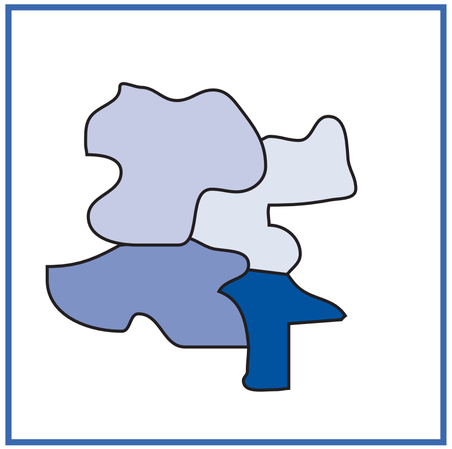


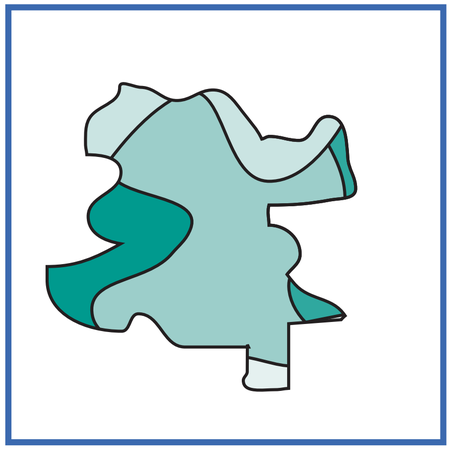
C	A	B
C1	A1	B1
C2	A1	B2
C3	A2	B4
C4	A2	B2
C5	A2	B3
C6	A1	B3

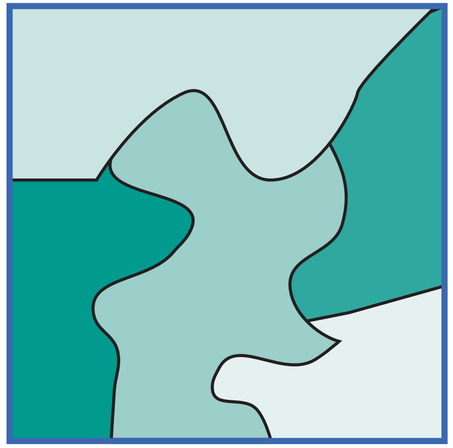
Spatial analysis: overlay (operations)



CLIP BY

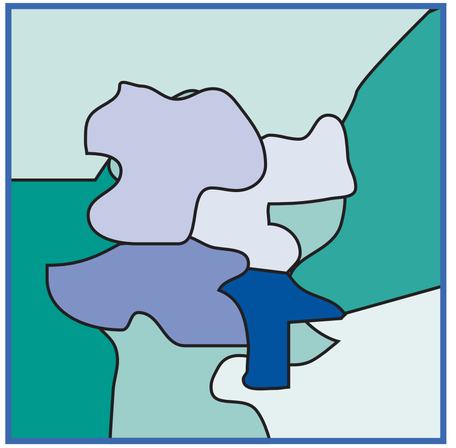




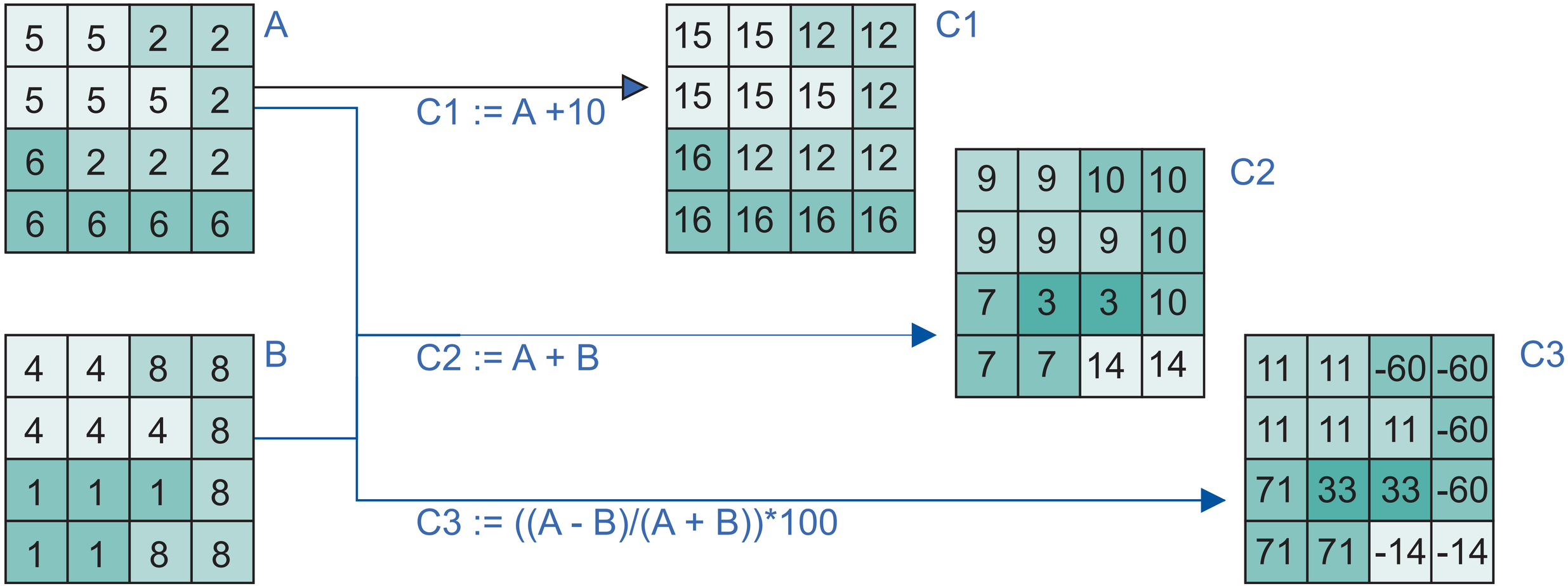


OVERWRITE BY

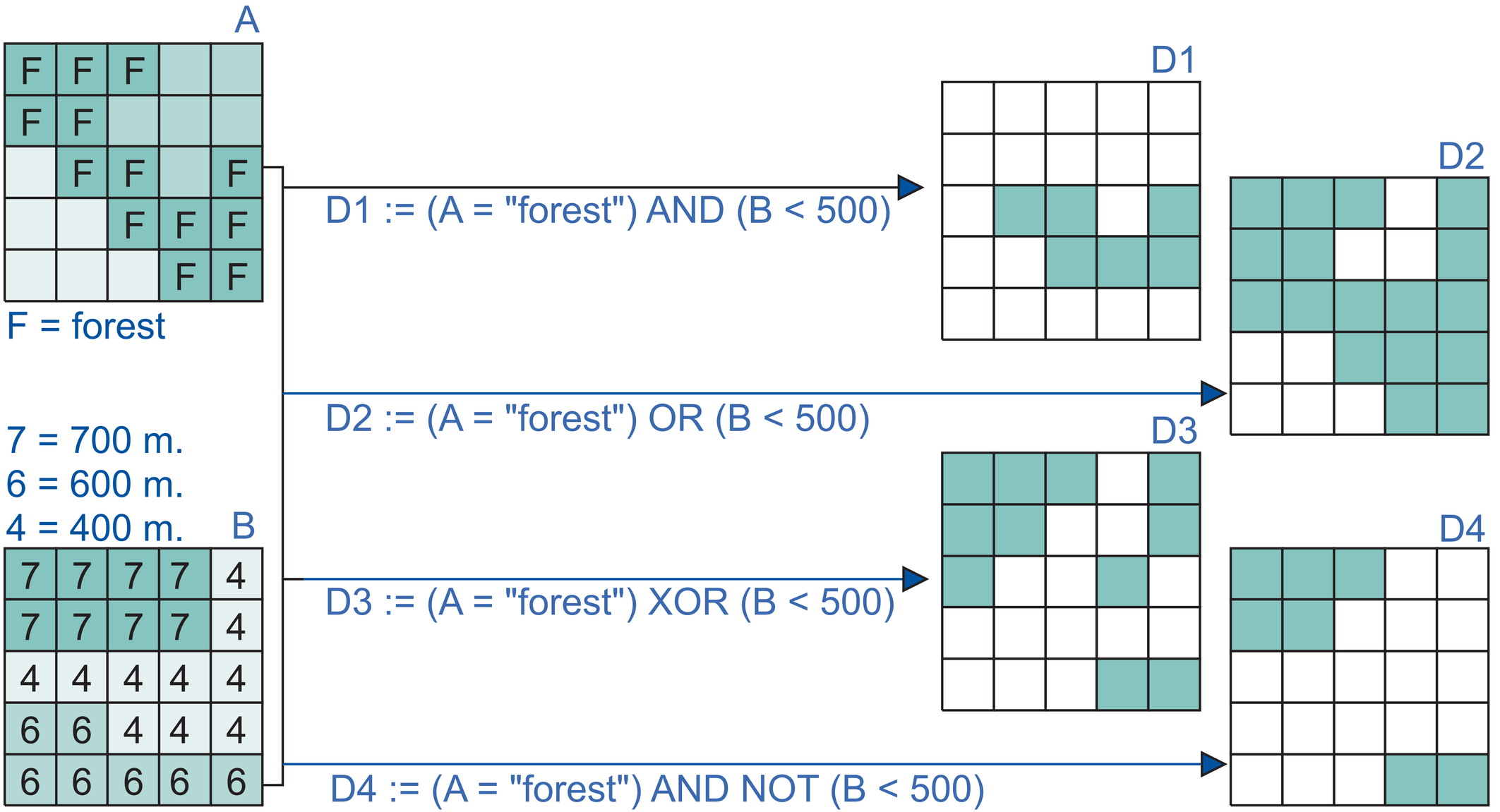




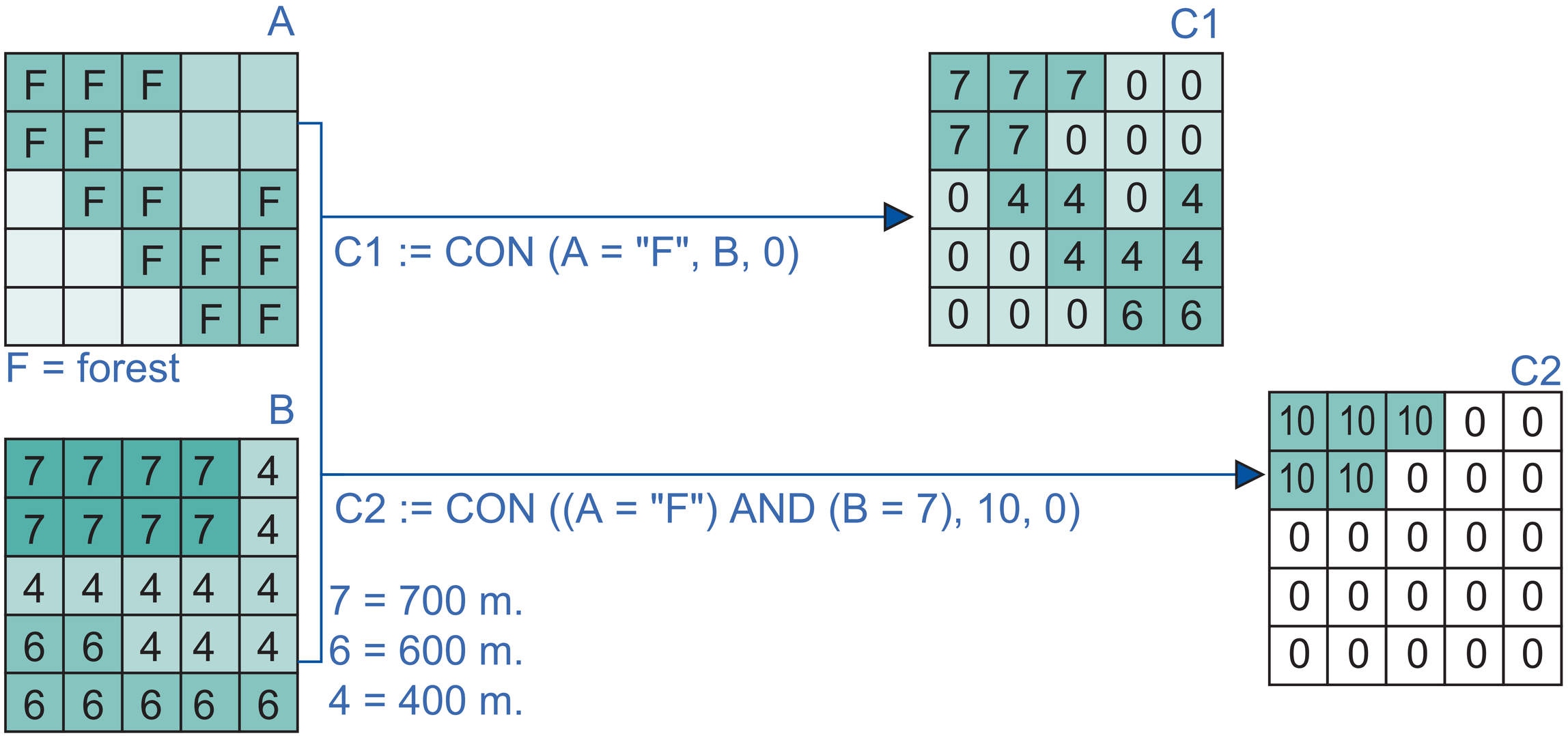
Spatial analysis: overlay (map algebra)



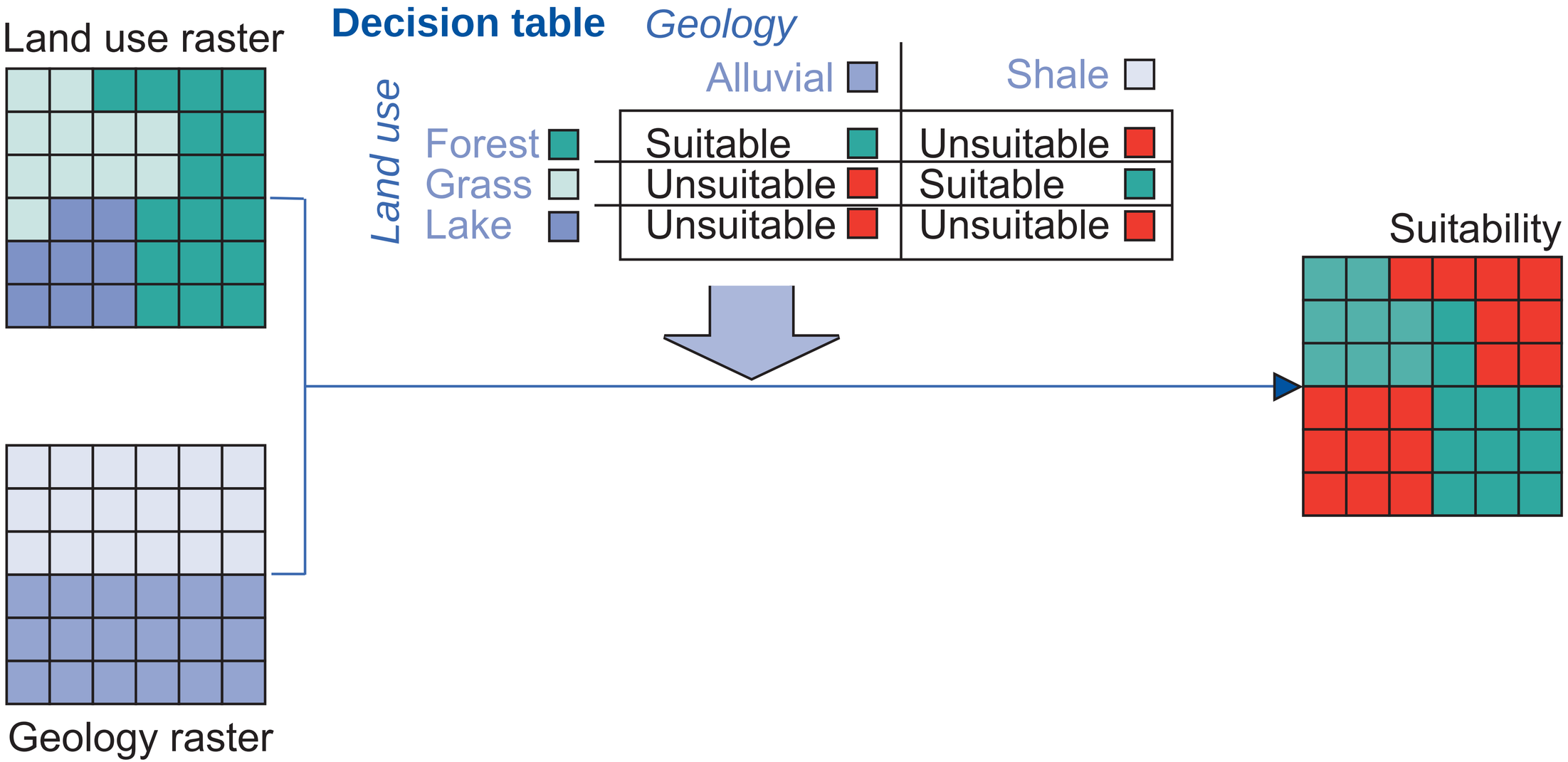
Spatial analysis: overlay (map algebra)



Spatial analysis: overlay (map algebra)



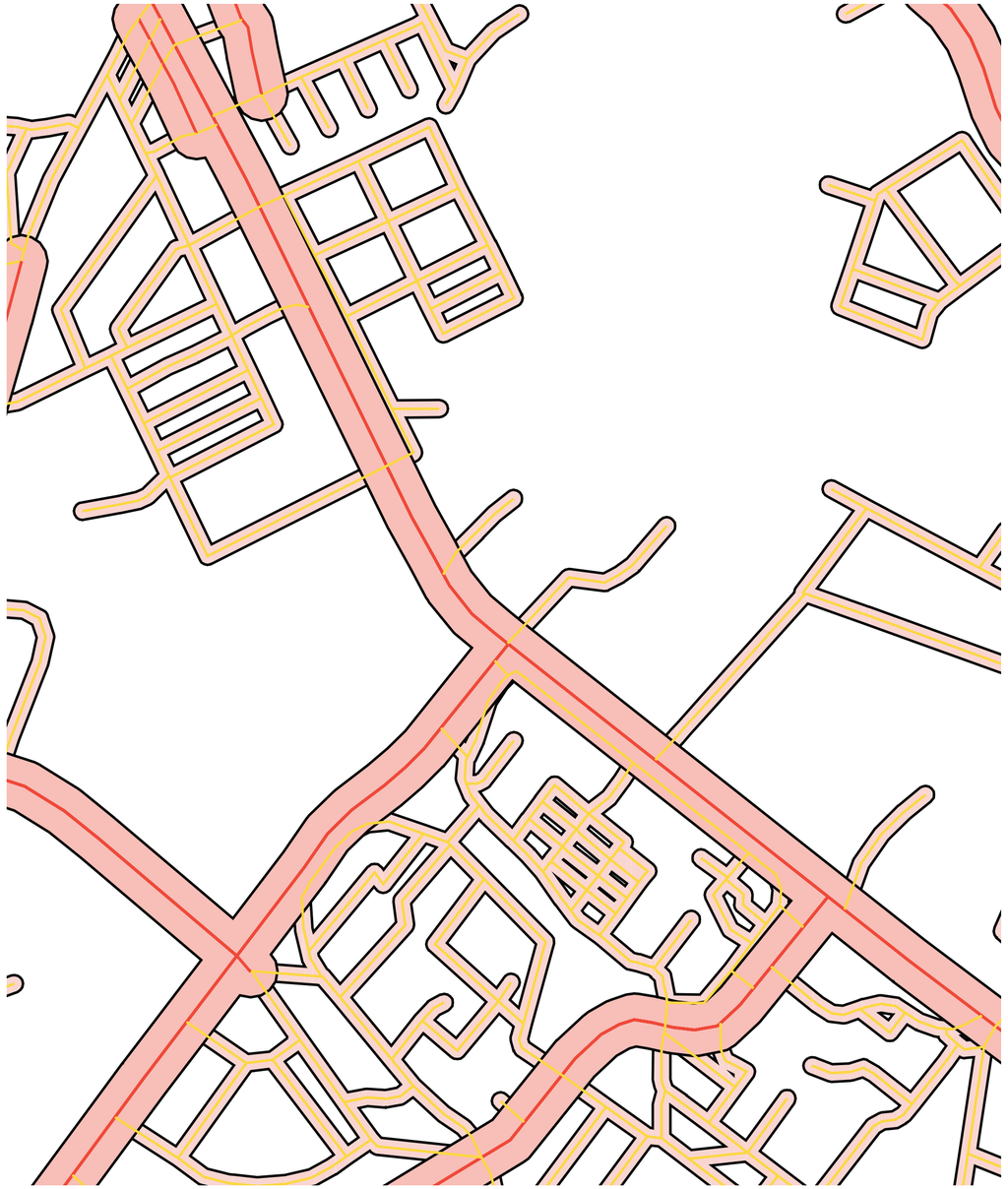
Spatial analysis: overlay (map algebra)



Spatial analysis: neighbourhood

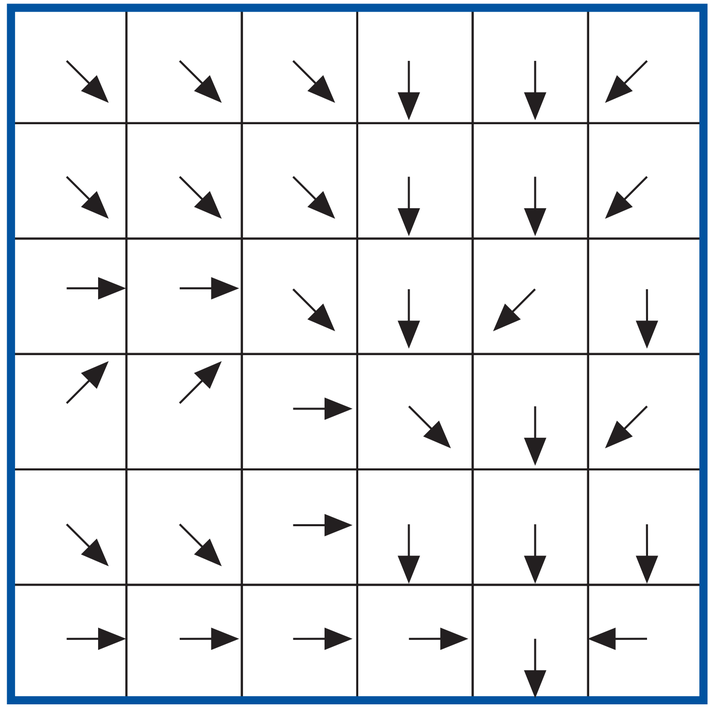
- **Neighbourhood** functions evaluate the characteristics of an area surrounding a feature's location.

- Example: Buffer zone generation using 25 metres for minor roads and 75 metres for main roads.



Spatial analysis: neighbourhood

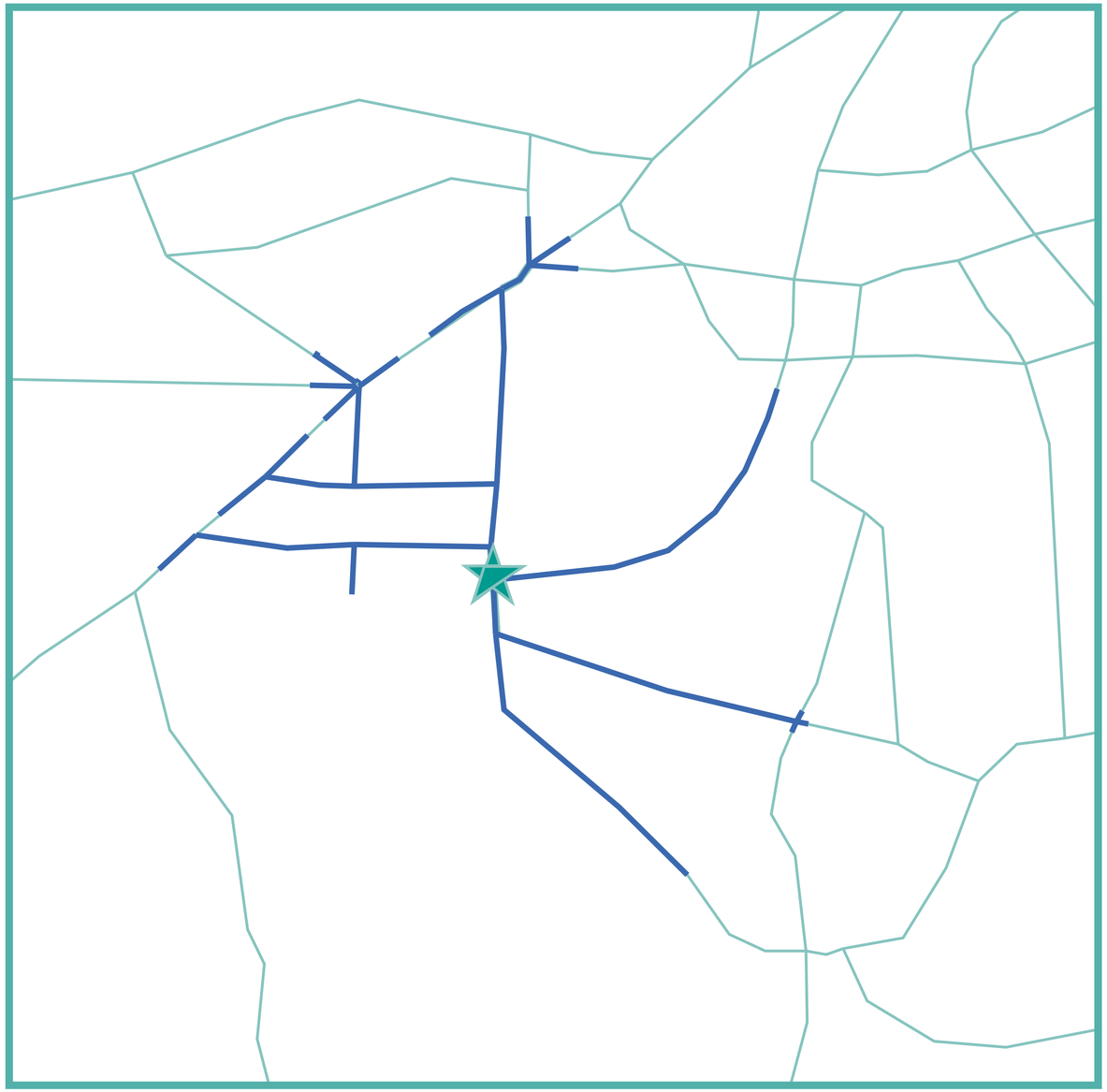
156	144	138	142	116	98
148	134	112	98	92	100
138	106	88	74	76	96
128	116	110	44	62	48
136	122	94	42	32	38
148	106	68	24	22	24



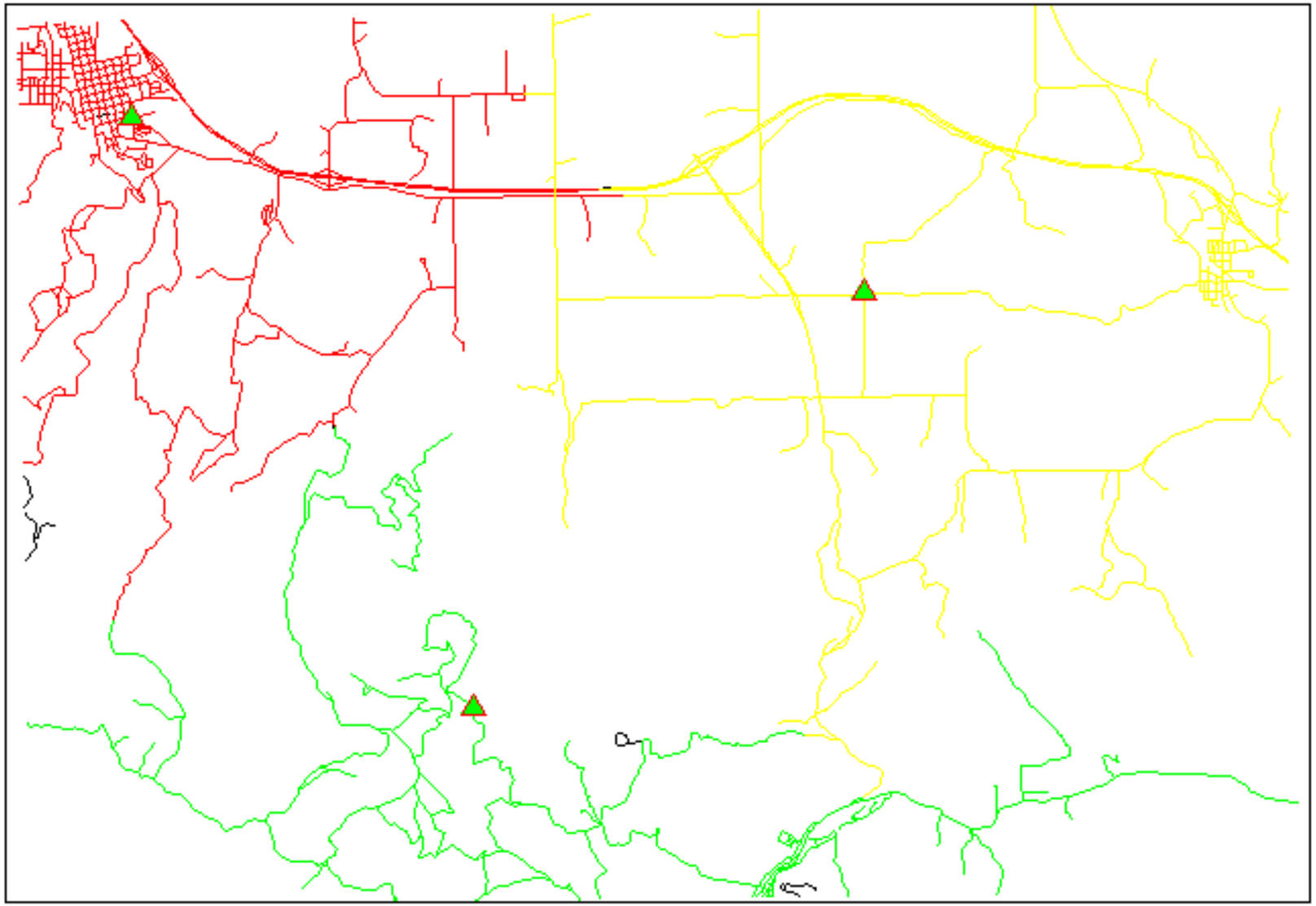
0	0	0	0	0	0
0	1	1	2	2	0
0	3	7	5	4	0
0	0	0	20	0	1
0	0	0	1	24	0
0	2	4	7	35	1

Spatial analysis: connectivity

- **Connectivity** functions work on the basis of networks, including road networks, water courses in coastal zones, and communication lines in mobile telephony.
- These networks represent spatial linkages between features.
- Example: Network allocation on a pupil/school assignment problem, where the street segments within 2 km of the school are identified.



Spatial analysis: connectivity



Questions?

Processing 2D and 3D geodata contents

- Data preparation
- Spatial analysis
- Practical session



Practical session 2

- Create a map of a region of your interest by applying spatial analysis methods.
- Some ideas:
  - Compute the population density based on an absolute population dataset.
  - Compute another density measure, e.g. the density of roads or railways.
  - Check if there’s a correlation between two datasets, e.g. traffic and population, or conservation areas and land use.
- Look for a dataset from a national or regional agency. Alternatively, use a worldwide one like the Kontur population dataset.
- Use the print view to put map elements like scale, North arrow and legend.

3D city models

- Why 3D?
- 3D geometries in geoinformation (ISO19107)
- 3D city models
- Practical session



Image: Freepik

Why 3D?

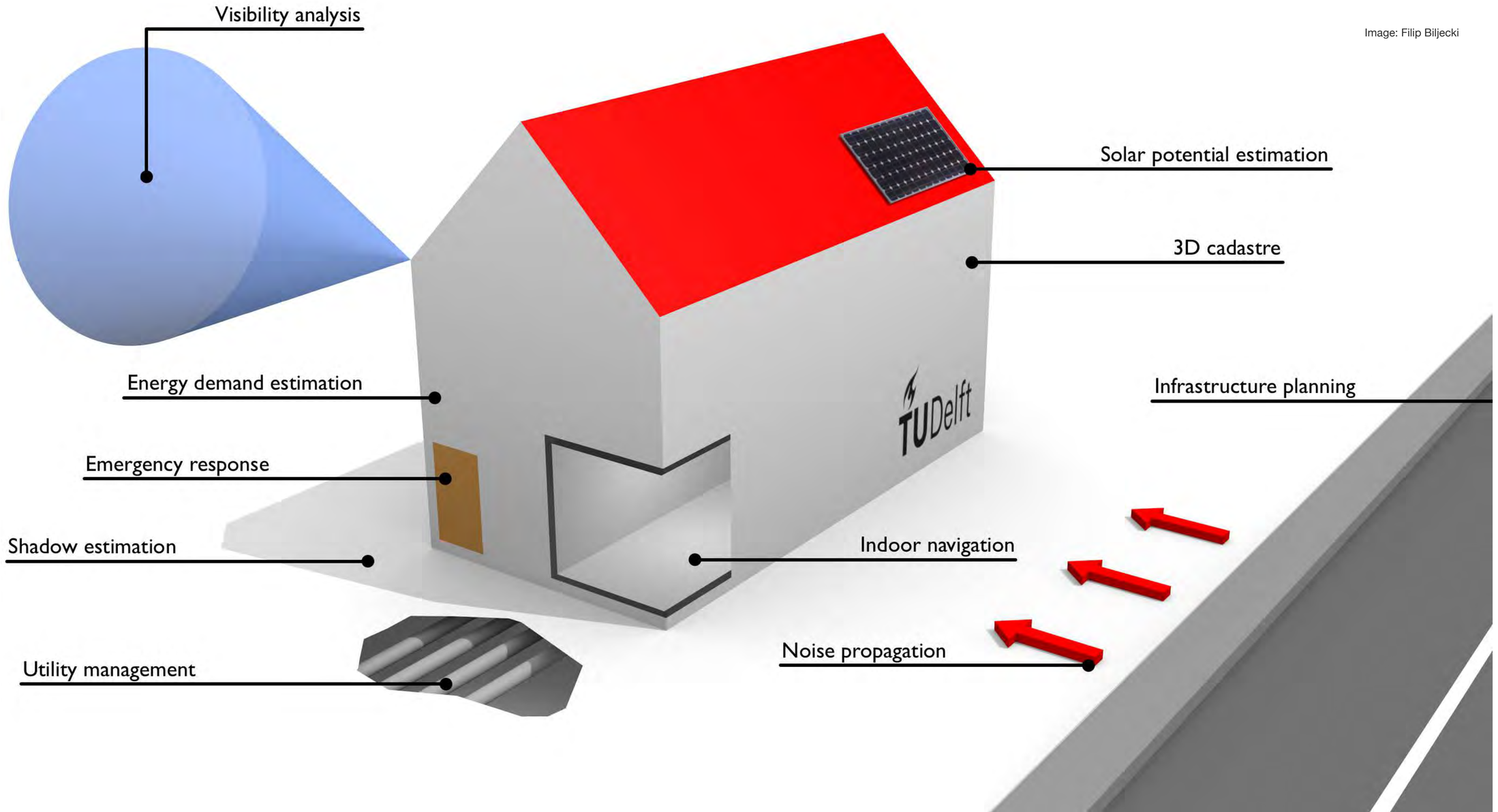
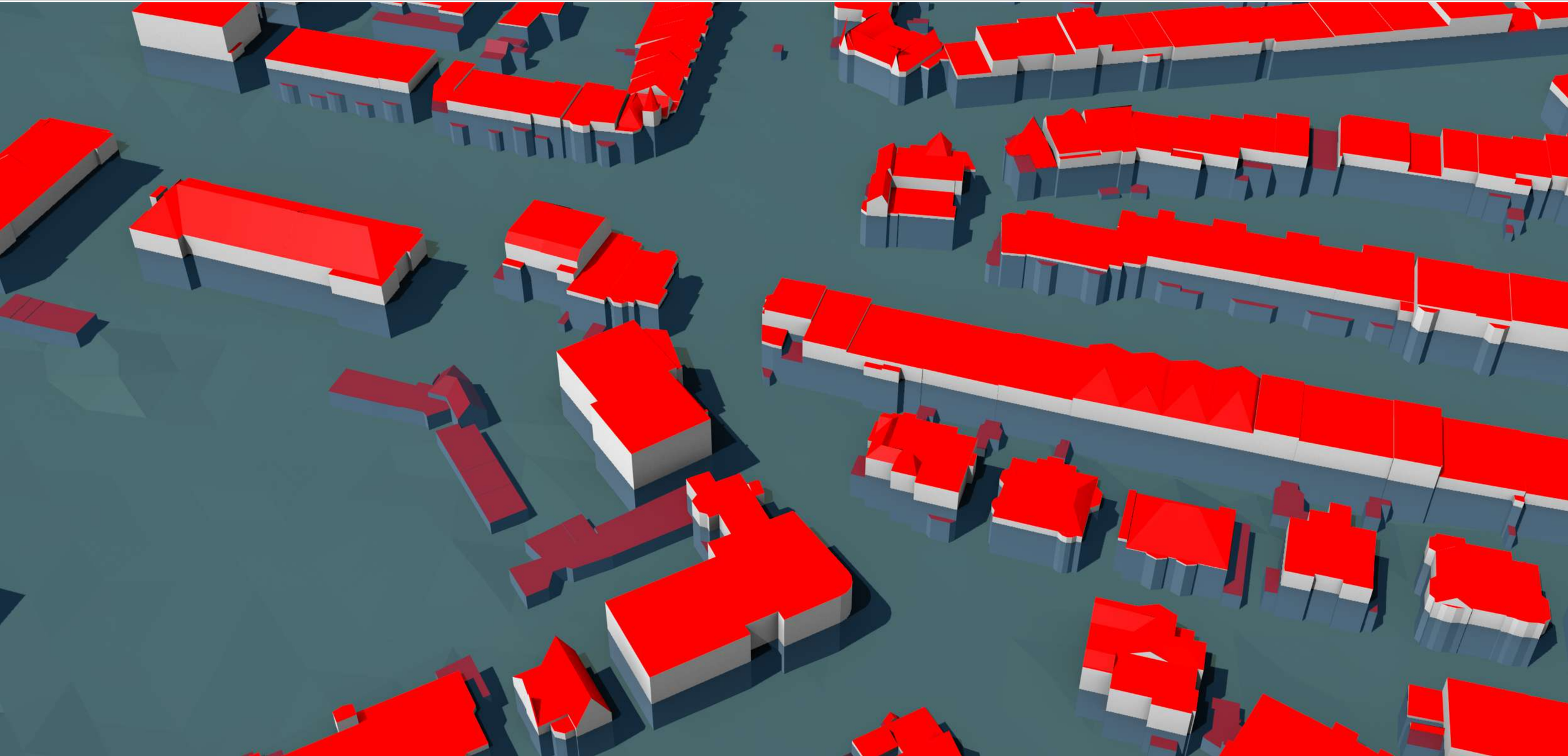


Image: Filip Biljecki

CHEK
DIGITAL BUILDING PERMIT

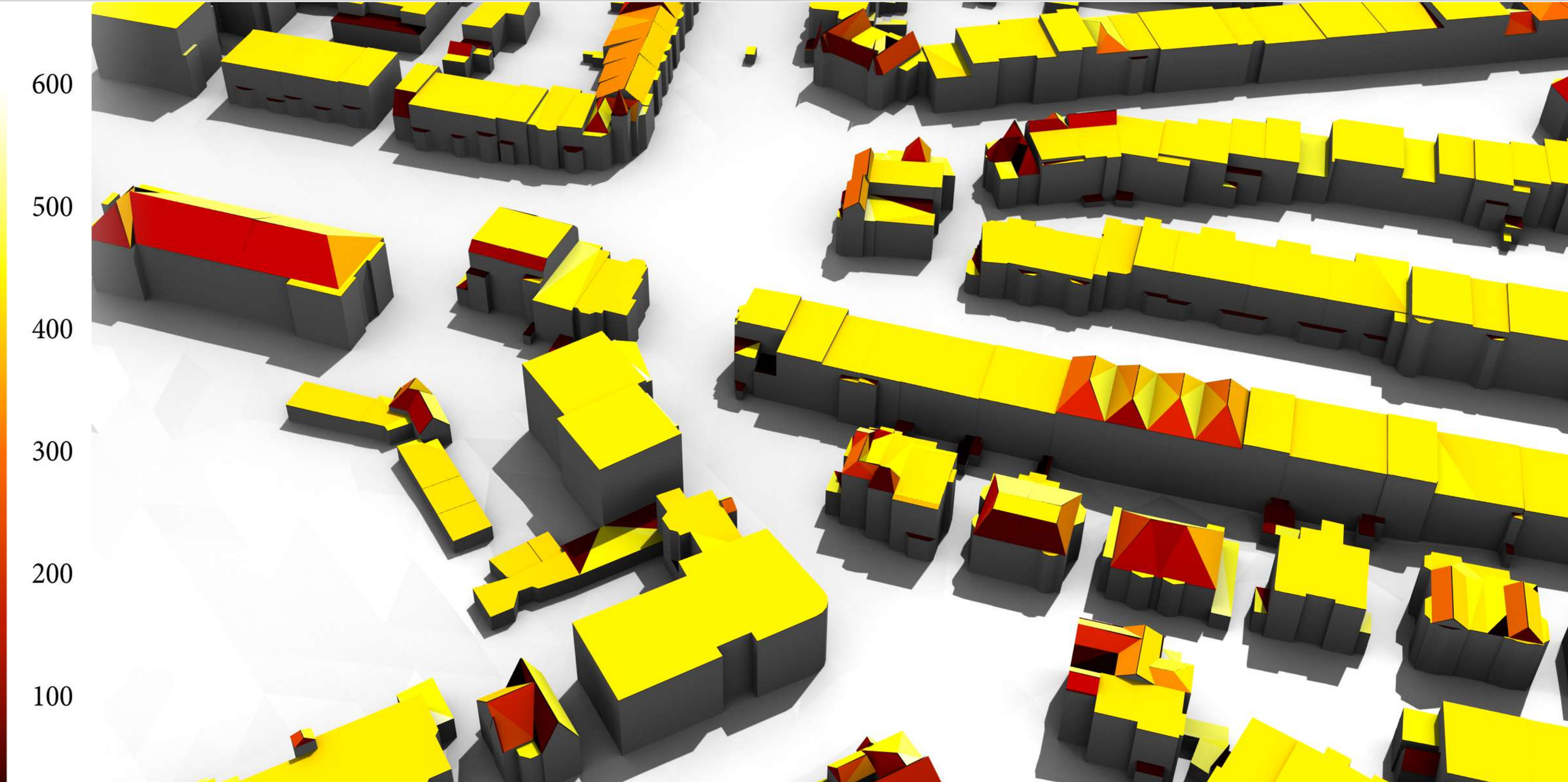
Why 3D?



Why 3D?



Why 3D?



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Why 3D?



Why 3D?

- Visualisation (e.g. for gaming, tourism, navigation, etc)
- Energy demand estimation (and potential for retrofitting)
- Computational fluid dynamics (e.g. for wind speeds, air quality, effects on buildings, etc)
- Shadow casting (e.g. for building permits, visibility analysis, improving energy demand/solar potential calculations, etc)

3D city models

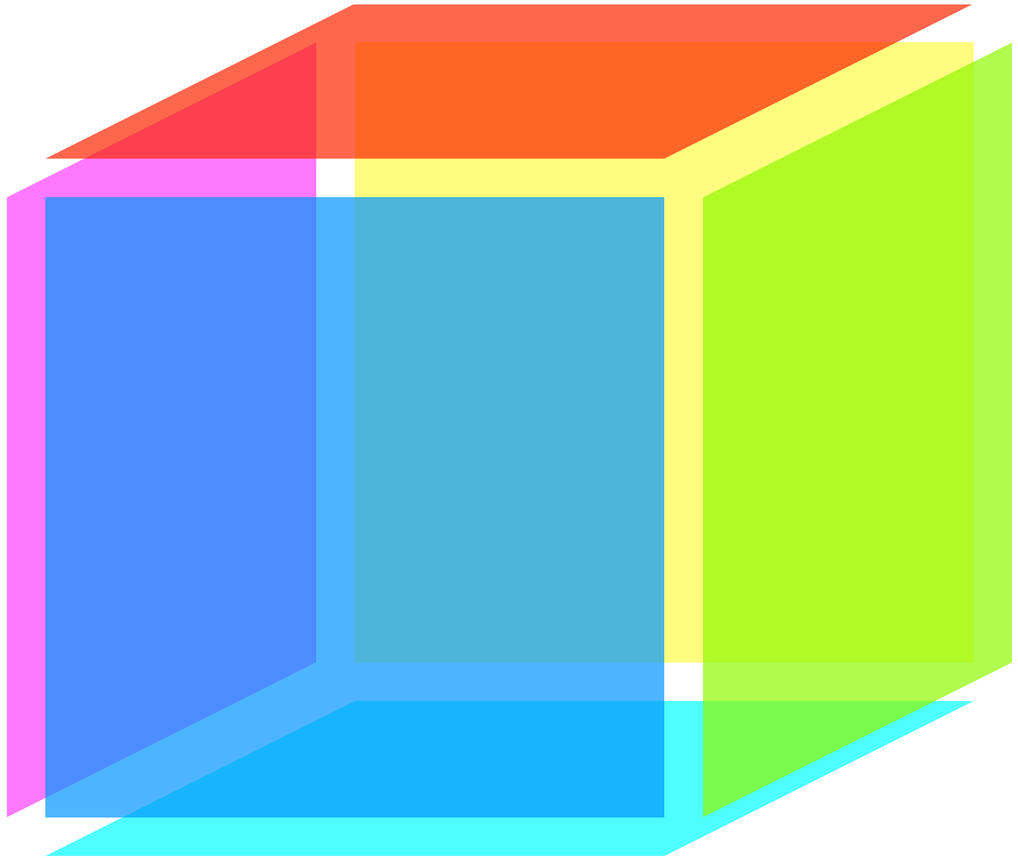
- Why 3D?
- 3D geometries in geoinformation (ISO19107)
- 3D city models
- Practical session



Image: Freepik

Boundary representation

- Also known as b-rep or surface modelling
- Representing an n-dimensional object through its $(n-1)$-dimensional boundary
- Most of the time: a 3D object through its 2D boundary



Boundary representation in 3D GIS

- Store 3D objects by storing their 2D boundary
- … which can be split into a set of surfaces (in GIS usually triangles or polygons)
- … which can be represented using a (2D) mesh, i.e. a repetitive arrangement of simpler elements

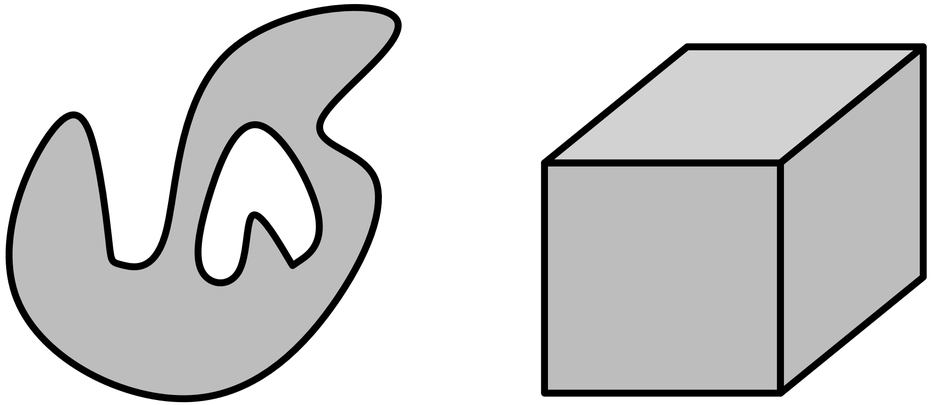
- note: not the same as a 3D mesh (e.g. TEN)

3D geometries in geoinformation



0D
GM_Point

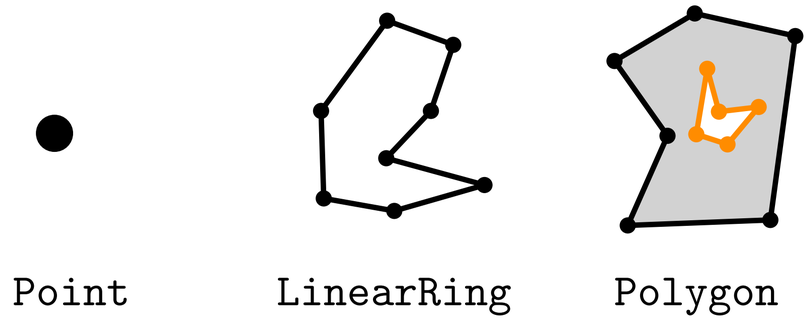
1D
GM_Curve



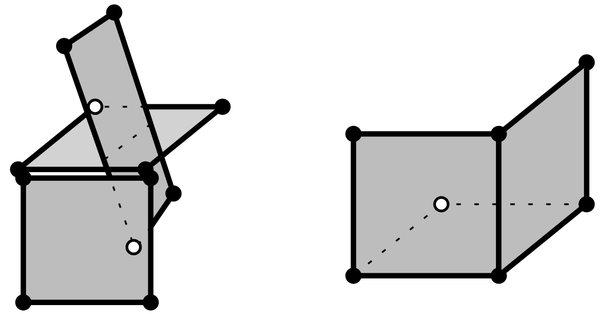
2D
GM_Surface

3D
GM_Solid

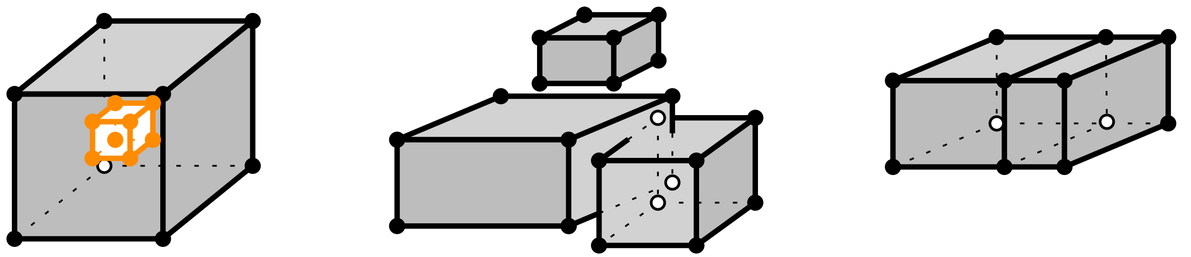
3D geometries in geoinformation



Point LinearRing Polygon

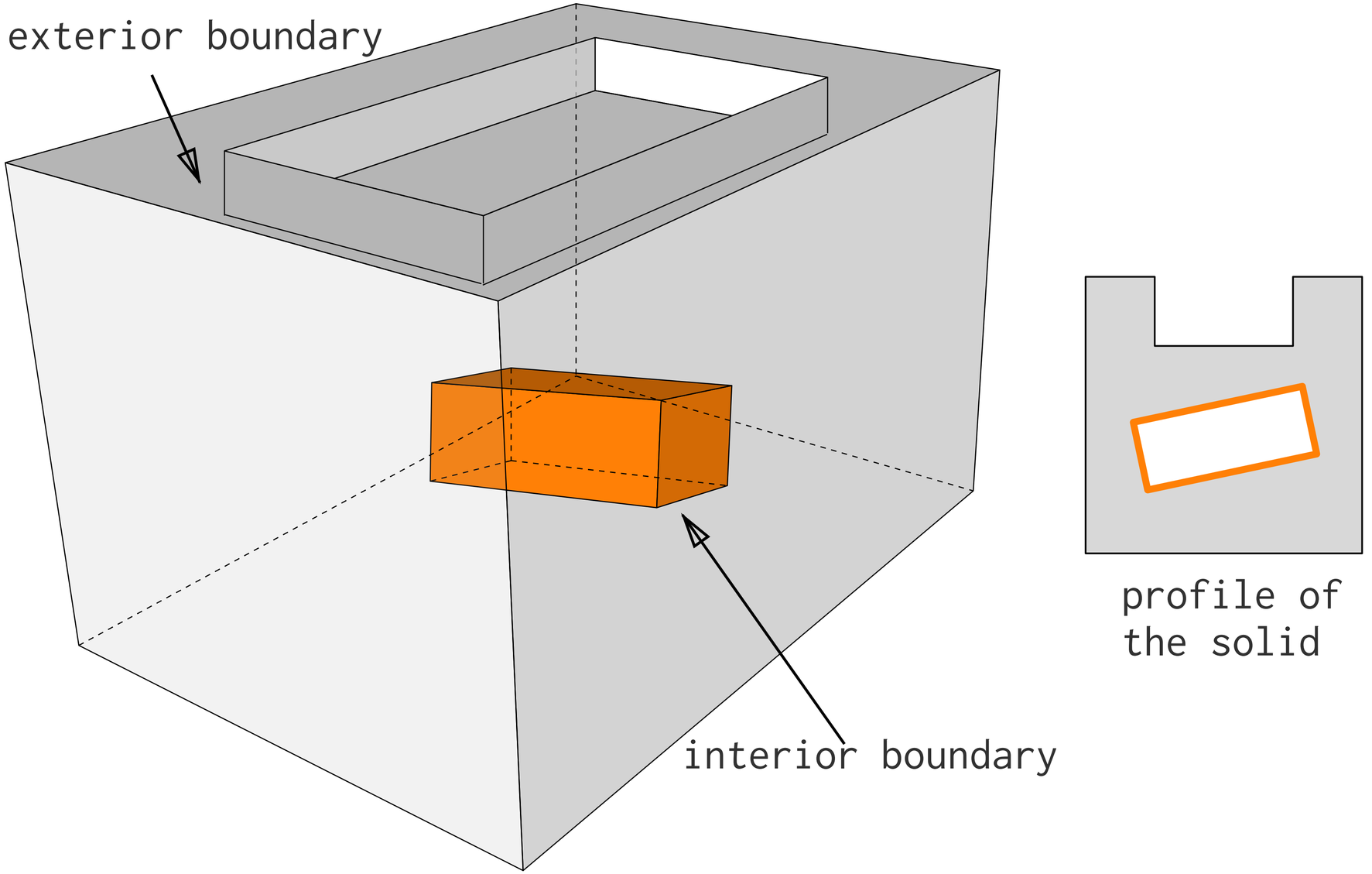


MultiSurface CompositeSurface

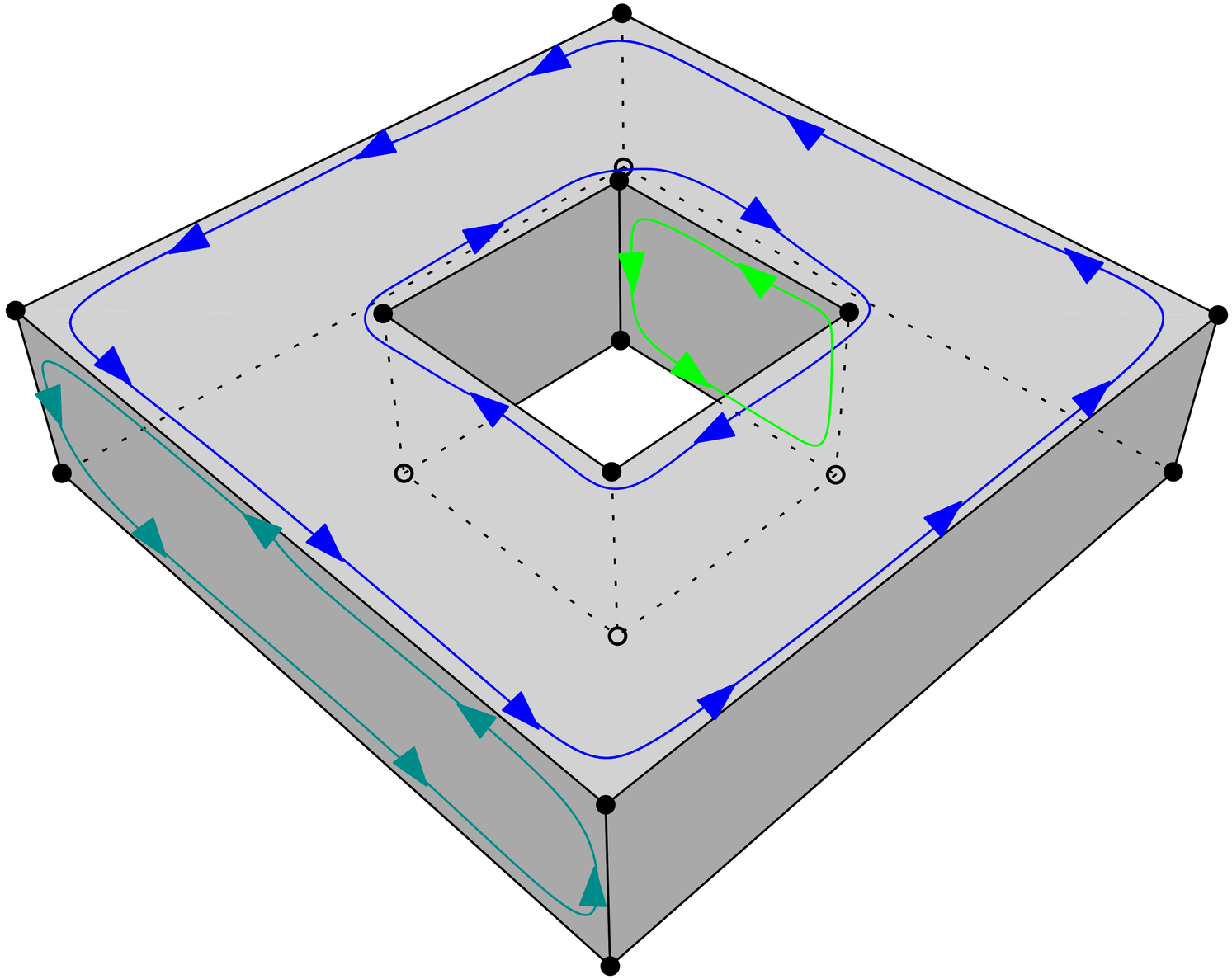


Solid MultiSolid CompositeSolid

3D geometries in geoinformation



3D geometries in geoinformation

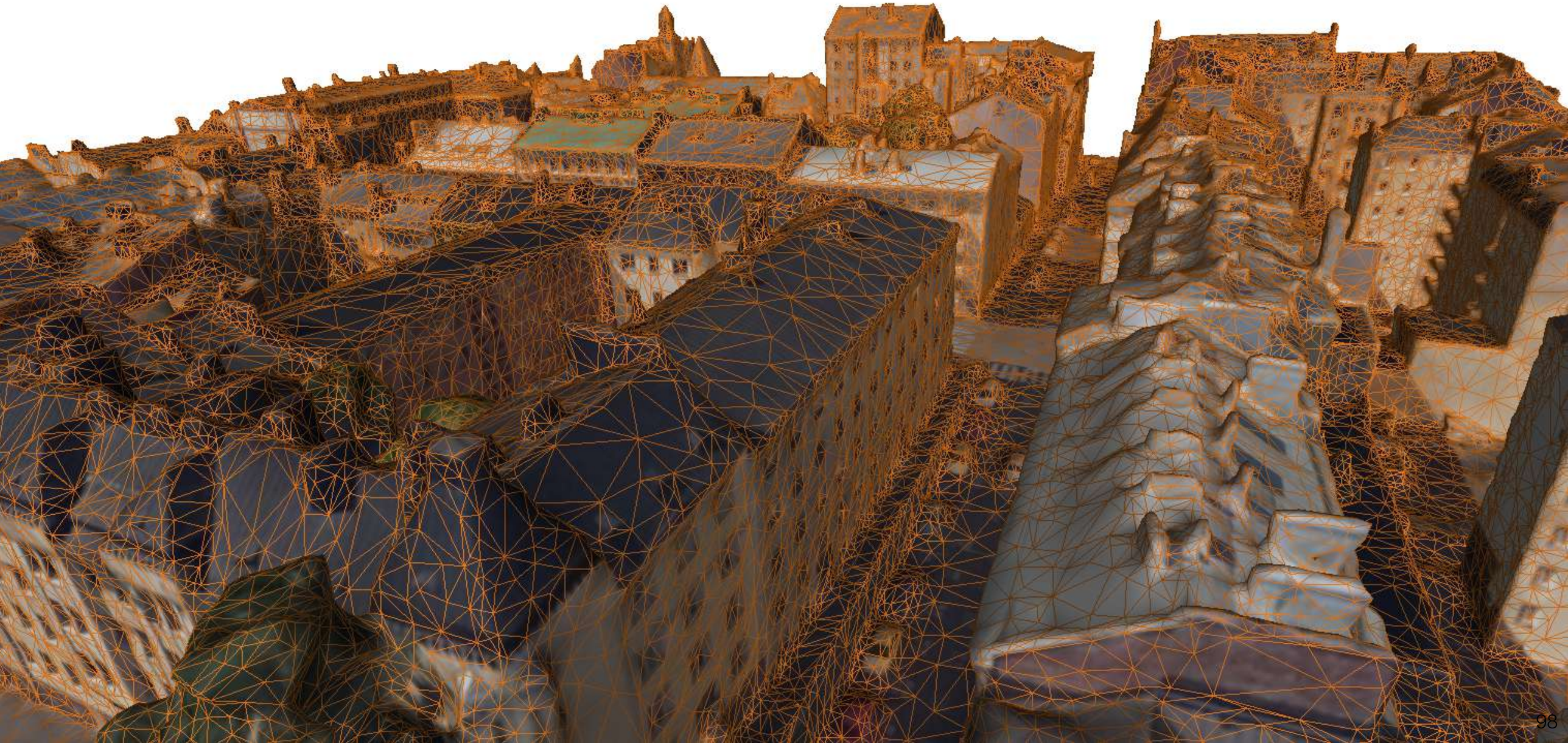


3D city models: contents

- Why 3D?
- 3D geometries in geoinformation (ISO19107)
- 3D city models
- Practical session



3D mesh



3D mesh

Difficult to answer:

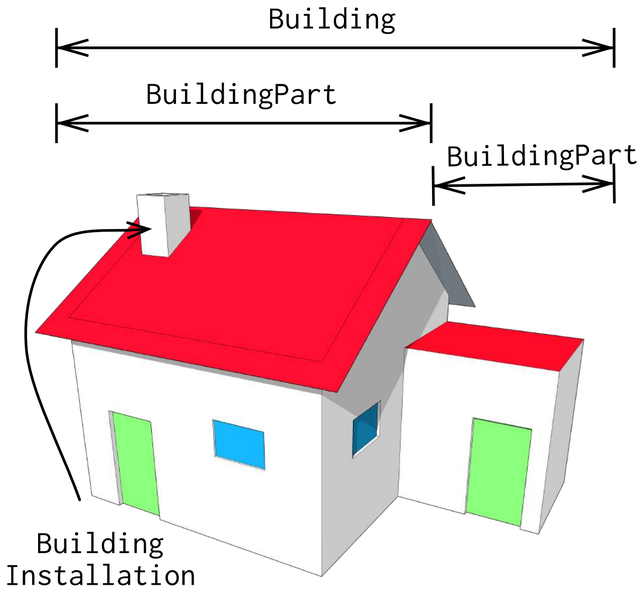
- How many windows does the main façade of a given building have?
- How many floors does a given building have?
- Can the local park be seen from the second floor of a given building?

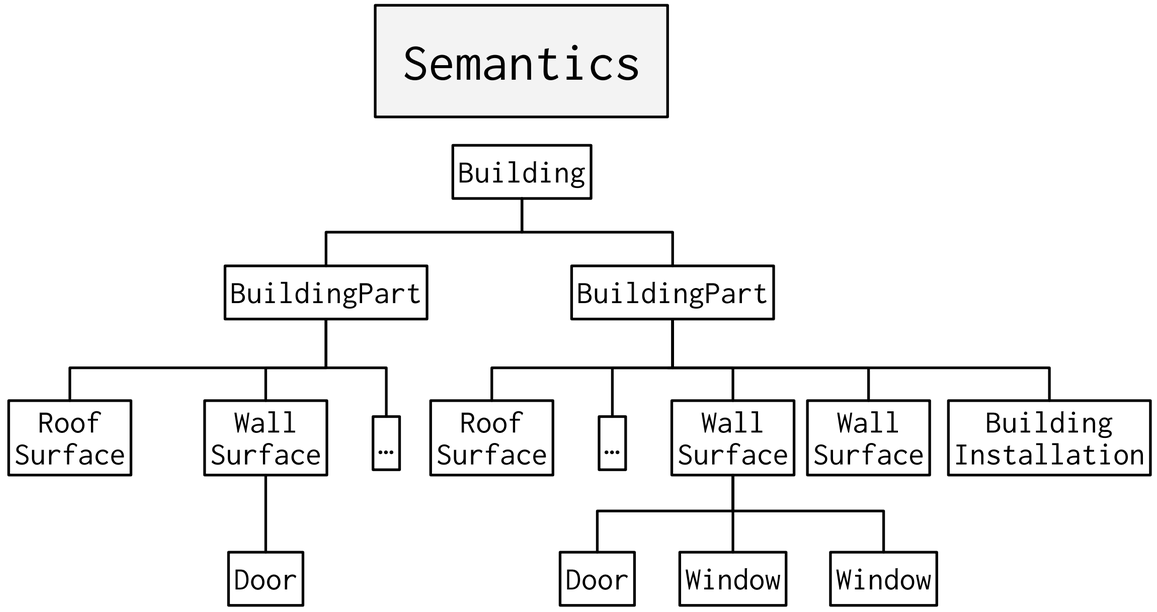
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3D city models



3D city models





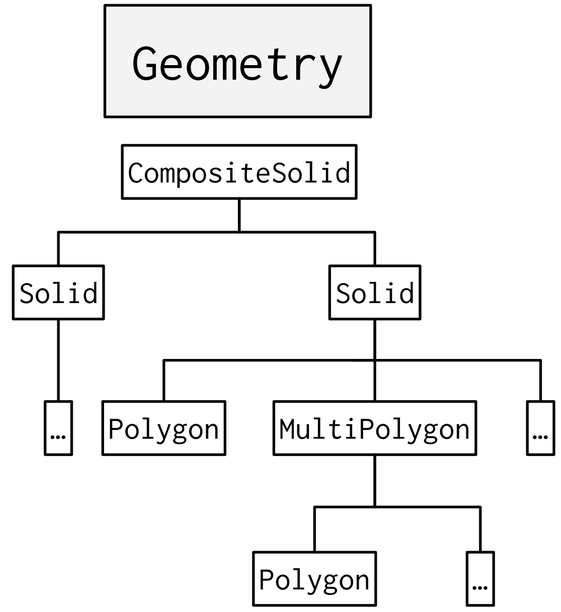
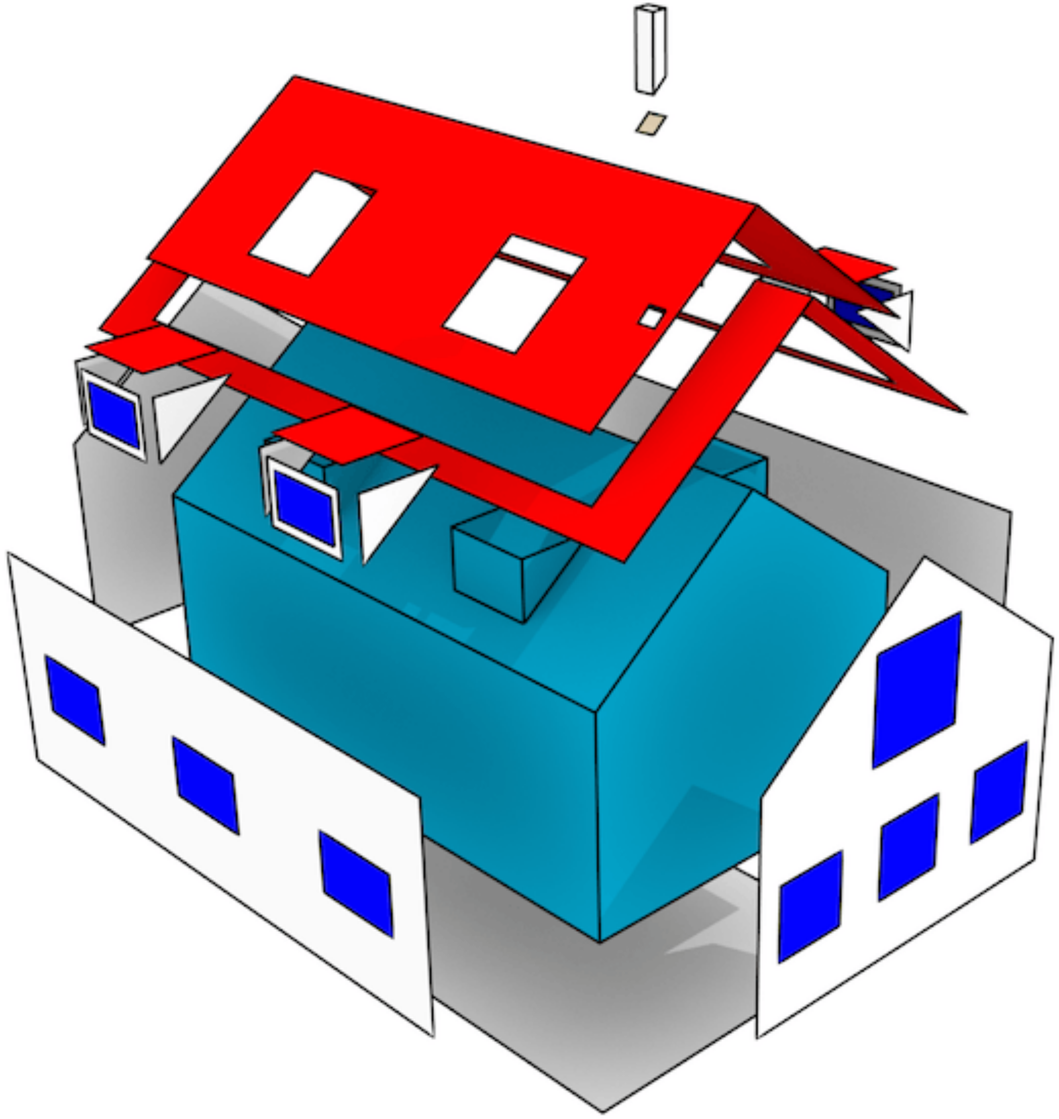
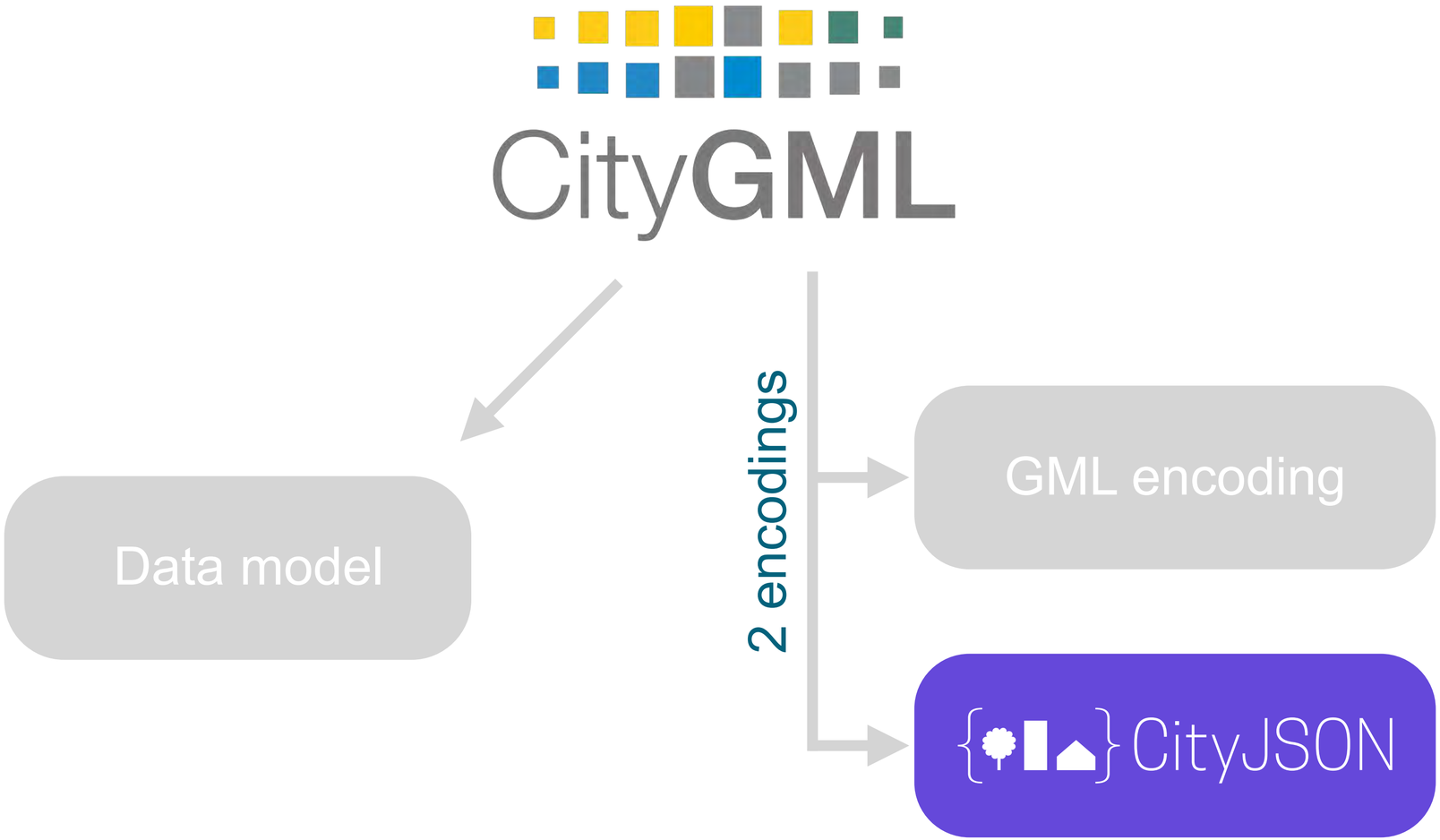


Image: Filip Biljecki

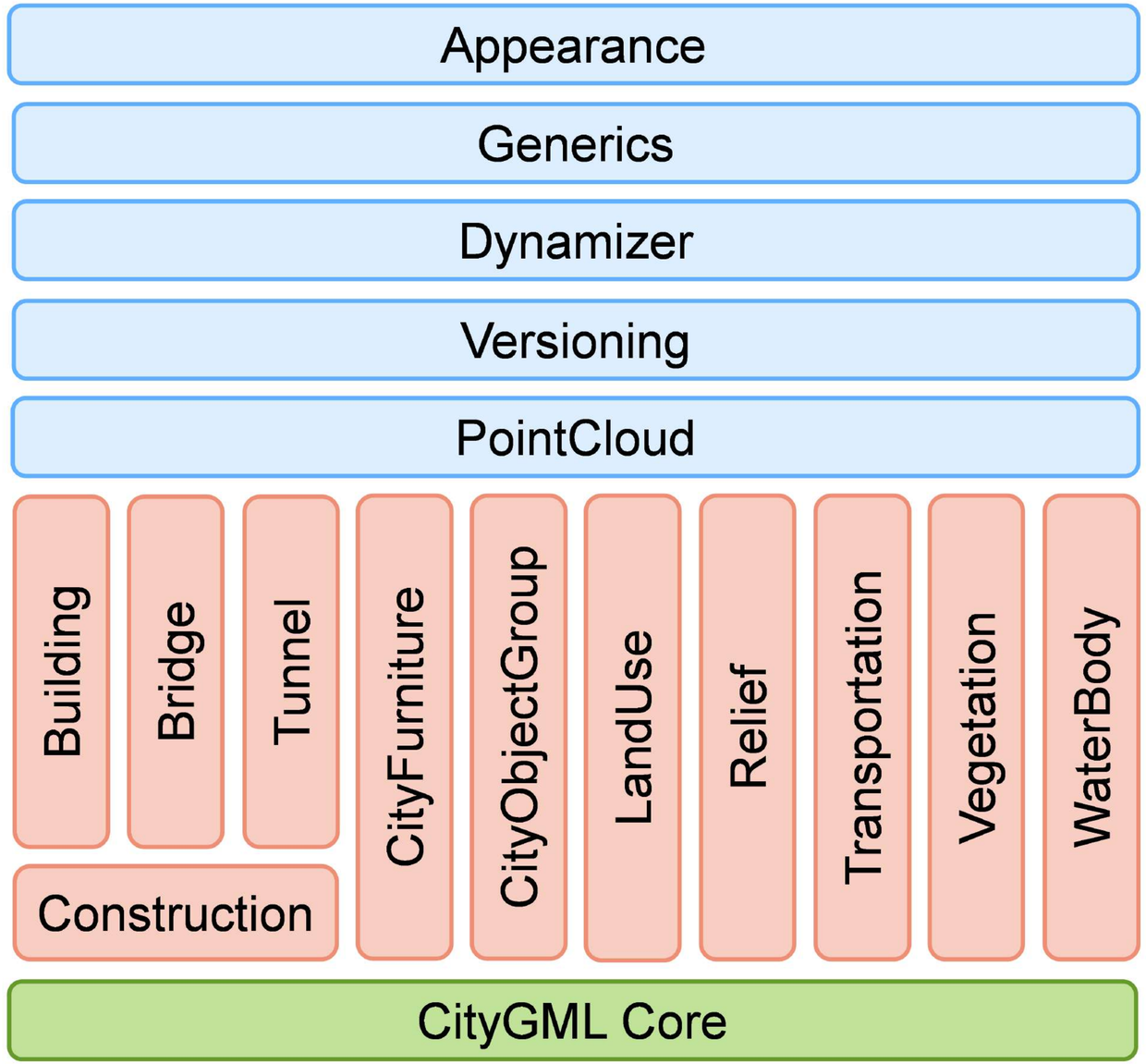
3D city models



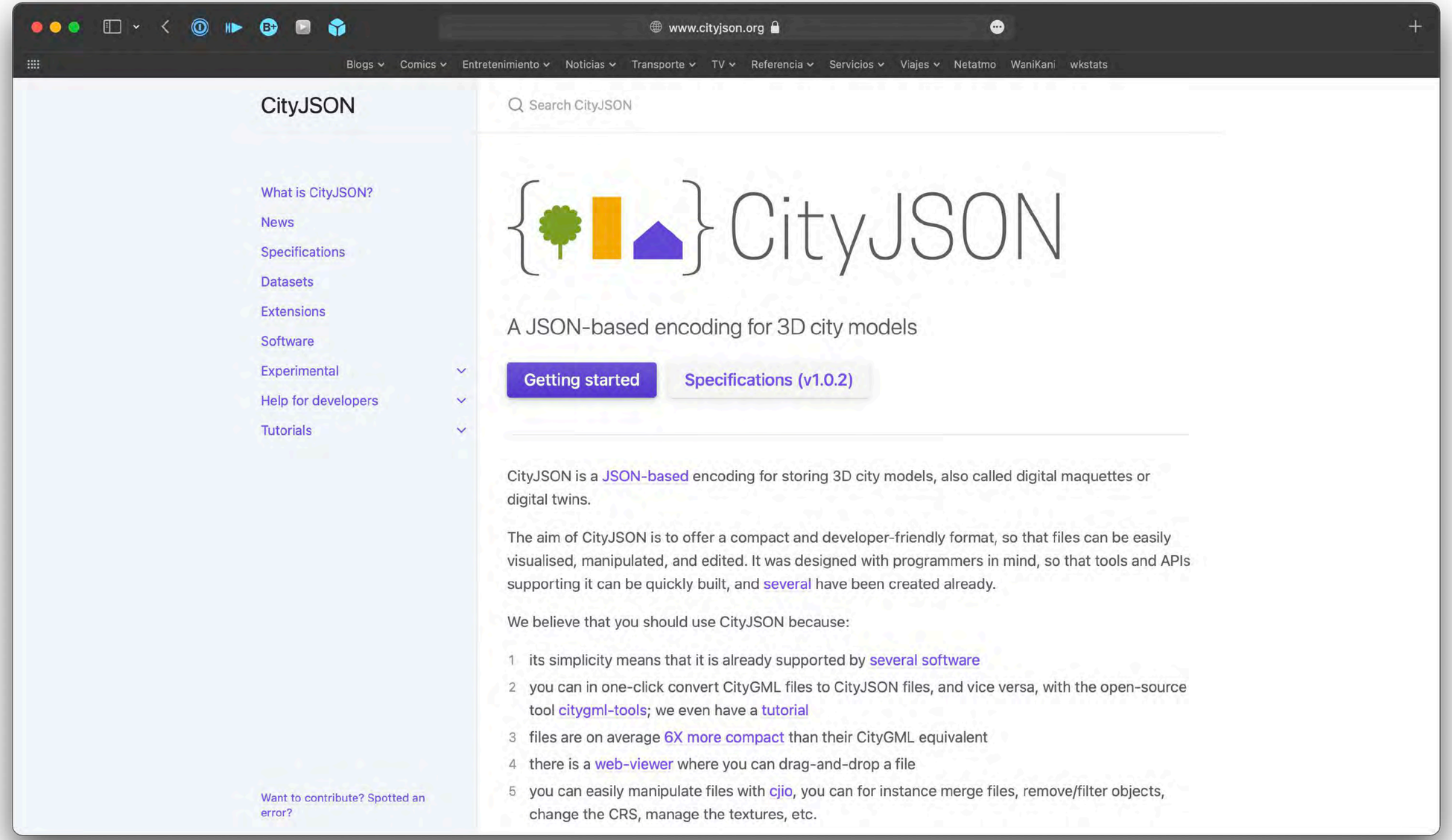
CityGML: data model and encodings



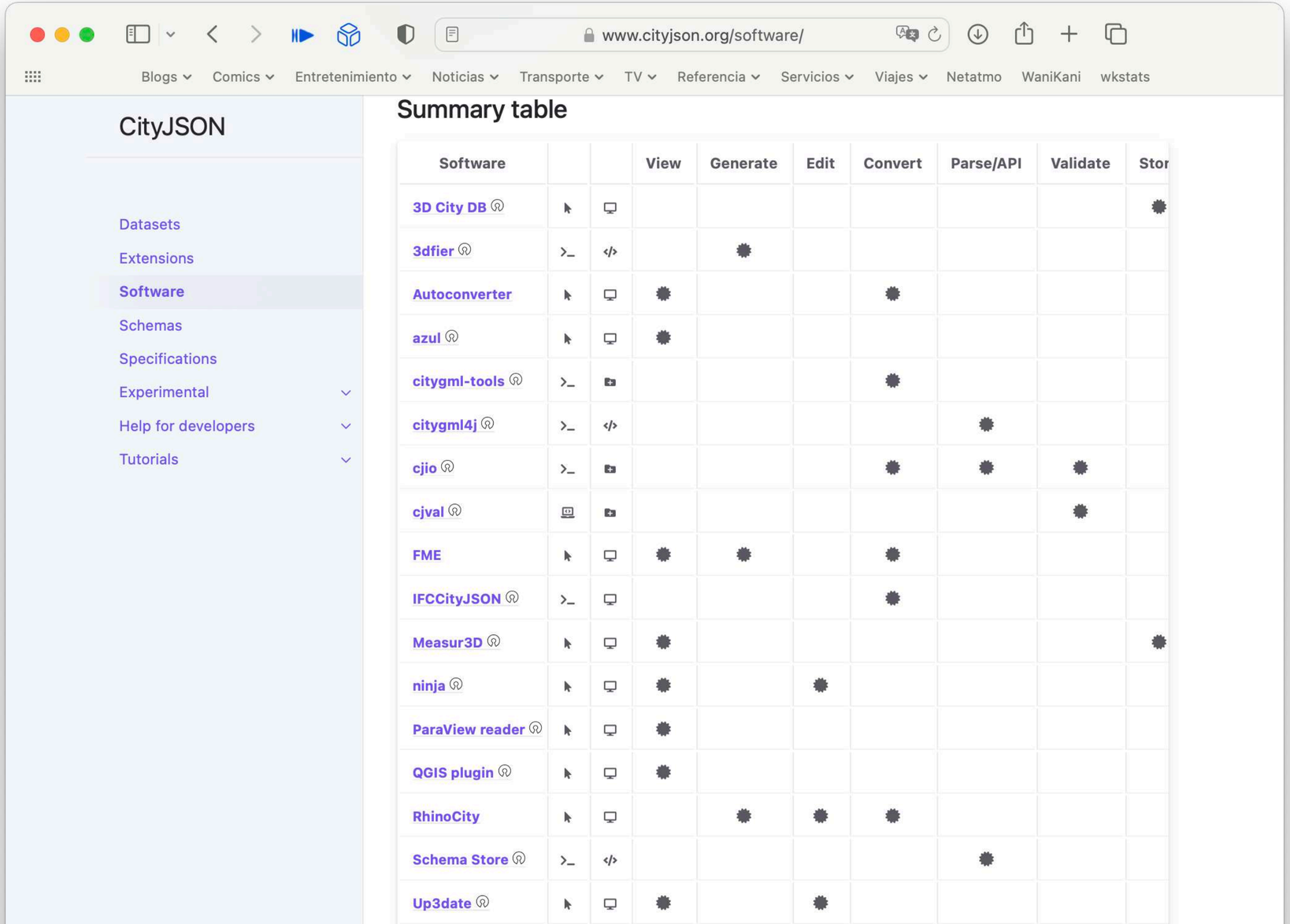
CityGML data model



CityJSON


www.cityjson.org
Blogs
Comics
Entretenimiento
Noticias
Transporte
TV
Referencia
Servicios
Viajes
Netatmo
WaniKani
wkstats
CityJSON
Search CityJSON
What is CityJSON?
News
Specifications
Datasets
Extensions
Software
Experimental
Help for developers
Tutorials
Want to contribute? Spotted an error?
CityJSON
A JSON-based encoding for 3D city models
Getting started
Specifications (v1.0.2)
CityJSON is a JSON-based encoding for storing 3D city models, also called digital maquettes or digital twins.
The aim of CityJSON is to offer a compact and developer-friendly format, so that files can be easily visualised, manipulated, and edited. It was designed with programmers in mind, so that tools and APIs supporting it can be quickly built, and several have been created already.
We believe that you should use CityJSON because:
1 its simplicity means that it is already supported by several software
2 you can in one-click convert CityGML files to CityJSON files, and vice versa, with the open-source tool citygml-tools; we even have a tutorial
3 files are on average 6X more compact than their CityGML equivalent
4 there is a web-viewer where you can drag-and-drop a file
5 you can easily manipulate files with cjio, you can for instance merge files, remove/filter objects, change the CRS, manage the textures, etc.

CityJSON for users



CityJSON for developers

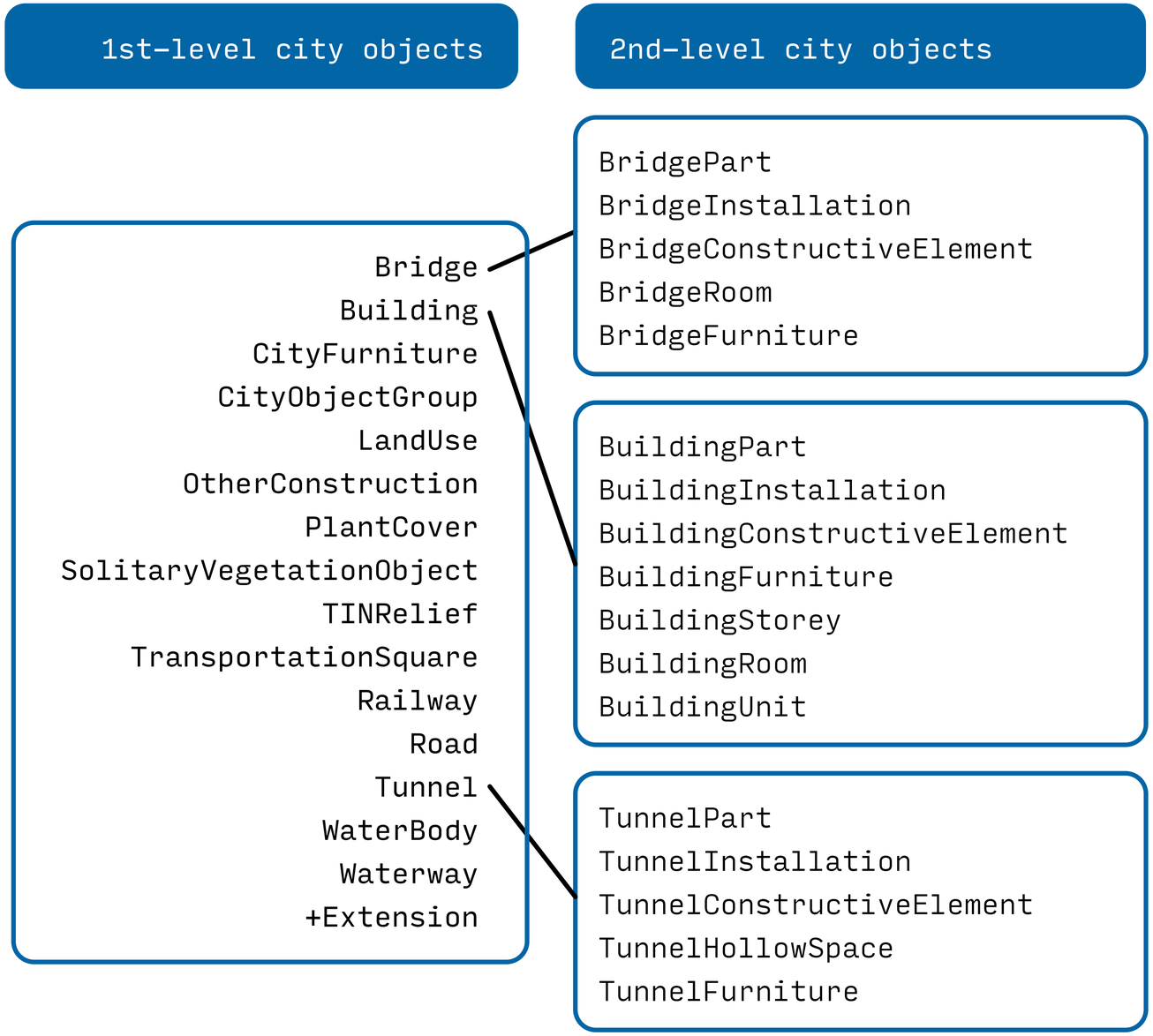
```python
import json

fin = open('mycity.json')
cm = json.loads(fin.read())

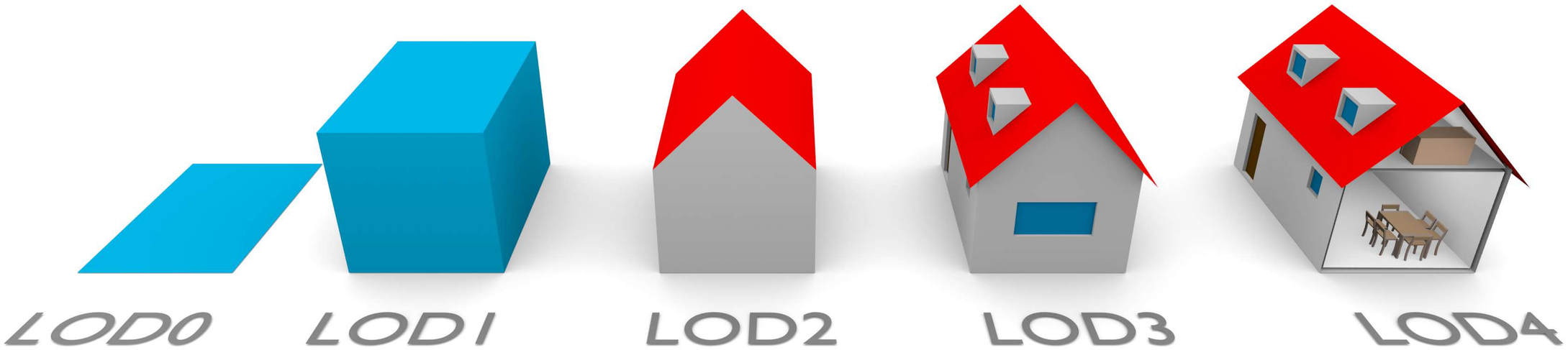
print "There are", len(cm['CityObjects']), "CityObjects"

# list all ids
for id in cm['CityObjects']:
    print "\t", id
```

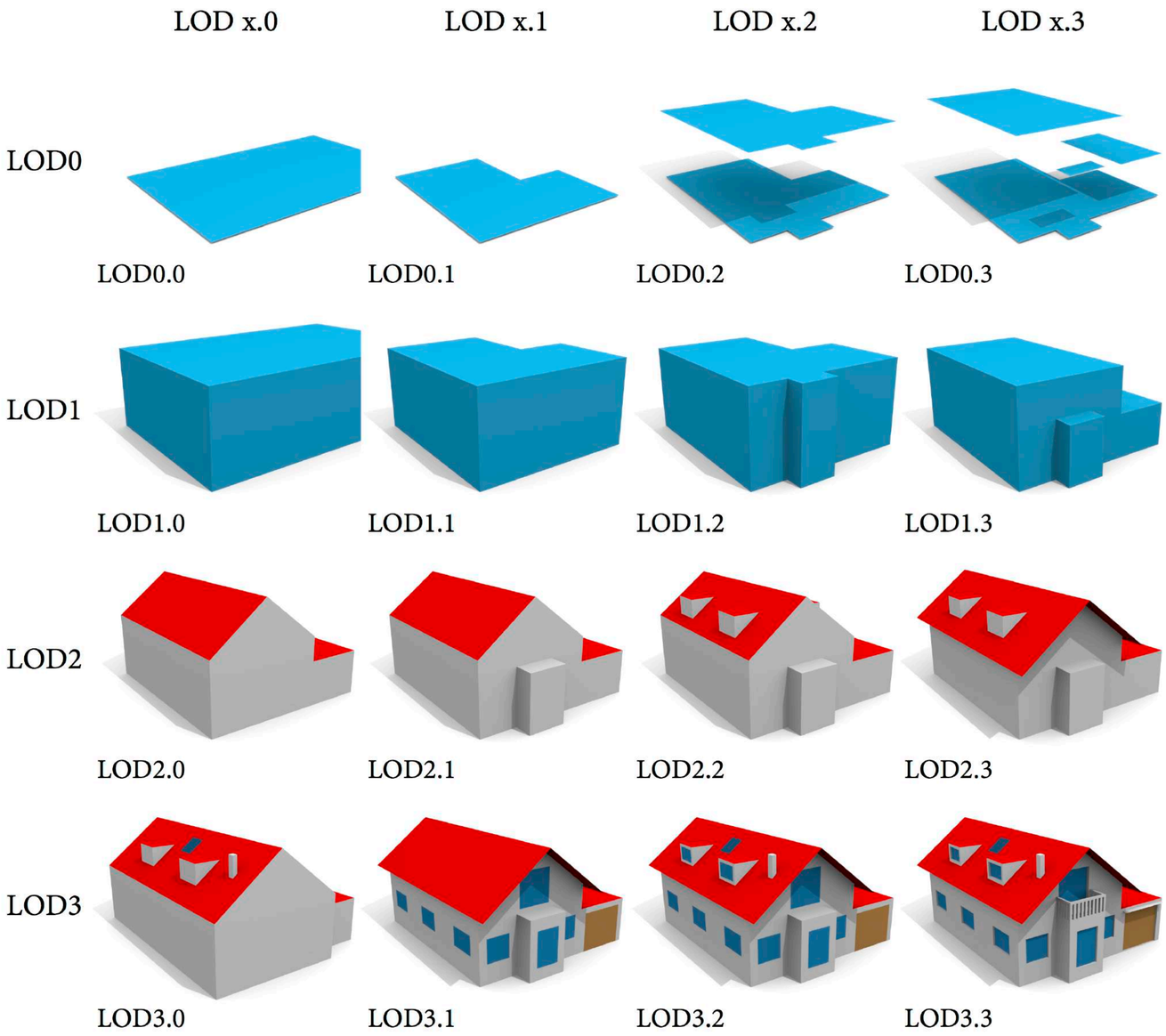
CityJSON


1st-level city objects
2nd-level city objects
Bridge
Building
CityFurniture
CityObjectGroup
LandUse
OtherConstruction
PlantCover
SolitaryVegetationObject
TINRelief
TransportationSquare
Railway
Road
Tunnel
WaterBody
Waterway
+Extension
BridgePart
BridgeInstallation
BridgeConstructiveElement
BridgeRoom
BridgeFurniture
BuildingPart
BuildingInstallation
BuildingConstructiveElement
BuildingFurniture
BuildingStorey
BuildingRoom
BuildingUnit
TunnelPart
TunnelInstallation
TunnelConstructiveElement
TunnelHollowSpace
TunnelFurniture

CityGML LoDs



Extended LoDs



CityJSON: general structure

```
{
  "type": "CityJSON",
  "version": "2.0",
  "extensions": {},
  "transform": {
    "scale": [1.0, 1.0, 1.0],
    "translate": [0.0, 0.0, 0.0]
  },
  "metadata": {},
  "CityObjects": {},
  "vertices": [],
  "appearance": {},
  "geometry-templates": {}
}
```

CityJSON: city objects

```
"CityObjects": {
  "id-1": {
    "type": "Building",
    "attributes": {
      "roofType": "gabled roof"
    },
    "geographicalExtent": [ 84710.1, 446846.0, -5.3, 84757.1, 446944.0, 40.9 ],
    "children": ["id-56", "id-832", "mybalcony"]
  },
  "id-56": {
    "type": "BuildingPart",
    "parents": ["id-1"],
    ...
  },
  "mybalcony": {
    "type": "BuildingInstallation",
    "parents": ["id-1"],
    ...
  }
  ...
}
```

CityJSON: city objects

```
"CityObjects": {
  "id-1": {
    "type": "LandUse",
    "attributes": {
      "function": "Industry and Business",
      "area-parcel": {
        "value": 437,
        "uom": "m2"
      },
    },
    "geometry": [{...}]
  },
  "id-2": {
    "type": "WaterBody",
    "attributes": {
      "name": "Lake Black",
      "some-list": ["a", "b", "c"]
    },
    "geometry": [{...}]
  }
}
```

CityJSON: vertices

```
"vertices": [
  [102, 103, 1],
  [11, 910, 43],
  [25, 744, 22],
  ...
  [23, 88, 5],
  [8523, 487, 22]
]
```

CityJSON: MultiPoint and MultiLineString

```
{
  "type": "MultiPoint",
  "lod": "1",
  "boundaries": [2, 44, 0, 7]
}
```

```
{
  "type": "MultiLineString",
  "lod": "1",
  "boundaries": [
    [2, 3, 5], [77, 55, 212]
  ]
}
```

CityJSON: MultiSurface (same as CompositeSurface)

```
{
  "type": "MultiSurface",
  "lod": "2",
  "boundaries": [
    [[0, 3, 2, 1]], [[4, 5, 6, 7]], [[0, 1, 5, 4]]
  ]
}
```

CityJSON: Solid

```
{
  "type": "Solid",
  "lod": "2",
  "boundaries": [
    //-- exterior shell
    [ [[0, 3, 2, 1, 22]], [[4, 5, 6, 7]], [[0, 1, 5, 4]], [[1, 2, 6, 5]] ],
    //-- interior shell
    [ [[240, 243, 124]], [[244, 246, 724]], [[34, 414, 45]], [[111, 246, 5]] ]
  ]
}
```

CityJSON: CompositeSolid (same as MultiSolid)

```
{
  "type": "CompositeSolid",
  "lod": "3",
  "boundaries": [
    [ //-- 1st Solid
      [ [[0, 3, 2, 1, 22]], [[4, 5, 6, 7]], [[0, 1, 5, 4]], [[1, 2, 6, 5]] ],
      [ [[240, 243, 124]], [[244, 246, 724]], [[34, 414, 45]], [[111, 246, 5]] ]
    ],
    [ //-- 2nd Solid
      [ [[666, 667, 668]], [[74, 75, 76]], [[880, 881, 885]], [[111, 122, 226]] ]
    ]
  ]
}
```

CityJSON: semantic surfaces

```
{
  "type": "RoofSurface",
  "slope": 16.4,
  "children": [2, 37],
  "solar-potential": 5
}
```

```
{
  "type": "Window",
  "parent": 2,
  "type-glass": "HR++"
}
```

CityJSON: semantic surfaces

```
{
  "type": "MultiSurface",
  "lod": "2",
  "boundaries": [
    [[0, 3, 2, 1]],
    [[4, 5, 6, 7]],
    [[0, 1, 5, 4]],
    [[0, 2, 3, 8]],
    [[10, 12, 23, 48]]
  ],
  "semantics": {
    "surfaces" : [
      {
        "type": "WallSurface",
        "slope": 33.4,
        "children": [2]
      },
      {
        "type": "RoofSurface",
        "slope": 66.6
      }
    ],
    "values": [0, 0, null, 1, 0]
  }
}
```

CityJSON: semantic surfaces

```
{
   "type": "CompositeSolid",
   "lod": "2.2",
   "boundaries": [
     [ //-- 1st Solid
       [ [[0, 3, 2, 1, 22]], [[4, 5, 6, 7]], [[0, 1, 5, 4]], [[1, 2, 6, 5]] ]
     ],
     [ //-- 2nd Solid
       [ [[666, 667, 668]], [[74, 75, 76]], [[880, 881, 885]] ]
     ]
   ],
   "semantics": {
     "surfaces" : [
       {
         "type": "RoofSurface"
       },
       {
         "type": "WallSurface"
       }
     ],
     "values": [
       [ //-- 1st Solid
         [0, 1, 1, null]
       ],
       [ //-- 2nd Solid get all null values
         [null, null, null]
       ]
     ]
   }
 }
```

CityJSON: geometry templates

```
"geometry-templates": {
  "templates": [
    {
      "type": "MultiSurface",
      "lod": "2.1",
      "boundaries": [
         [[0, 3, 2, 1]], [[4, 5, 6, 7]], [[0, 1, 5, 4]]
      ],
      "semantics": {
        "surfaces" : [
          {
            "type": "+Skylight",
          },
          {
            "type": "+PatioDoor",
          }
        ],
        "values": [0, 0, 1]
      }
    },
    ...
  ],
  "vertices-templates": [
    [0.0, 0.5, 0.0],
    ...
    [1.0, 1.0, 0.0],
    [0.0, 1.0, 0.0]
  ]
}
```

CityJSON: geometry templates


```
{
  "type": "SolitaryVegetationObject",
  "geometry": [
    {
      "type": "GeometryInstance",
      "template": 0,
      "boundaries": [372],
      "transformationMatrix": [
        2.0, 0.0, 0.0, 0.0,
        0.0, 2.0, 0.0, 0.0,
        0.0, 0.0, 2.0, 0.0,
        0.0, 0.0, 0.0, 1.0
      ]
    }
  ]
}
```

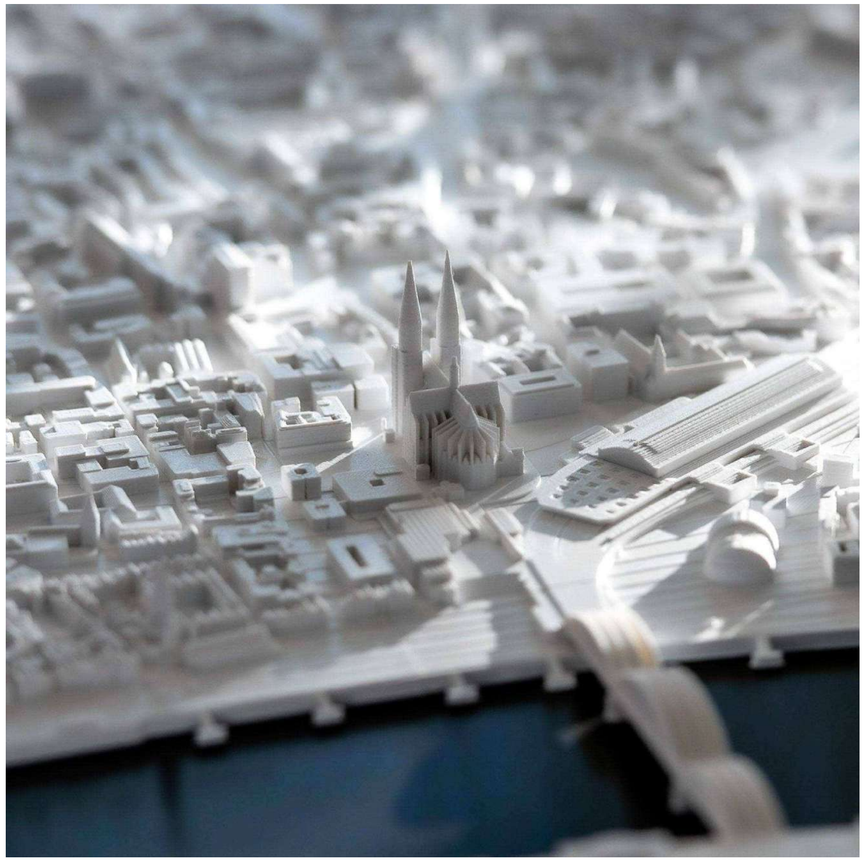
CityJSON: transform object

```
"transform": {
    "scale": [0.001, 0.001, 0.001],
    "translate": [442464.879, 5482614.692, 310.19]
}
```

Questions?

3D city models: contents

- Why 3D?
- 3D geometries in geoinformation (ISO19107)
- 3D city models
- Practical session



Cologne Image:cityframes.de/

Practical session 3

- Find a 3D city model that interests you in https://www.cityjson.org/datasets/
- Open it in CityJSON Ninja: https://ninja.cityjson.org/
- Analyse its main characteristics: which classes are included? what is its LoD or LoDs? which semantic surfaces are modelled?
- Try opening it in QGIS through the CityJSON plug-in. What happens? Check both the default view and the 3D Map.

References

- Otto Huisman and Rolf A. de By. **Principles of Geographic Information Systems**. 4th Edition. 2009.

- Matt Duckham, Qian (Chayn) Sun and Michael F. Worboys. **GIS: A Computing Perspective**. 3rd Edition. 2024.

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DIGITAL BUILDING PERMIT

Digital Transformation in Building Permits

Module 6 - Creation of 3D city models and GeoBIM integration

9th July 2025

Funded by
the European Union

Module 6 contents

- Creation of 3D city models
- Processing of 3D city models + practical session
- GeoBIM integration and conversions between Geo and BIM

Creation of 3D city models contents

- Overview of data sources and methods
- Reconstruction requirements and types
- 3D BAG method in detail

Creation of 3D city models: data sources

Most common:

- Topographic map as planar partition
- Land use / cadastral map
- Building footprints
- Road centrelines
- Urban mesh
- Object attributes (e.g. number of building stories or number of road lanes)
- Lidar point clouds (aerial or terrestrial)
- Photogrammetric mesh or point cloud
- DSM / DTM

Creation of 3D city models: methods

Most common:

- Lifting 2D semantic data to given height
- Fusion of 2D semantic data with point cloud
- Classification of urban mesh

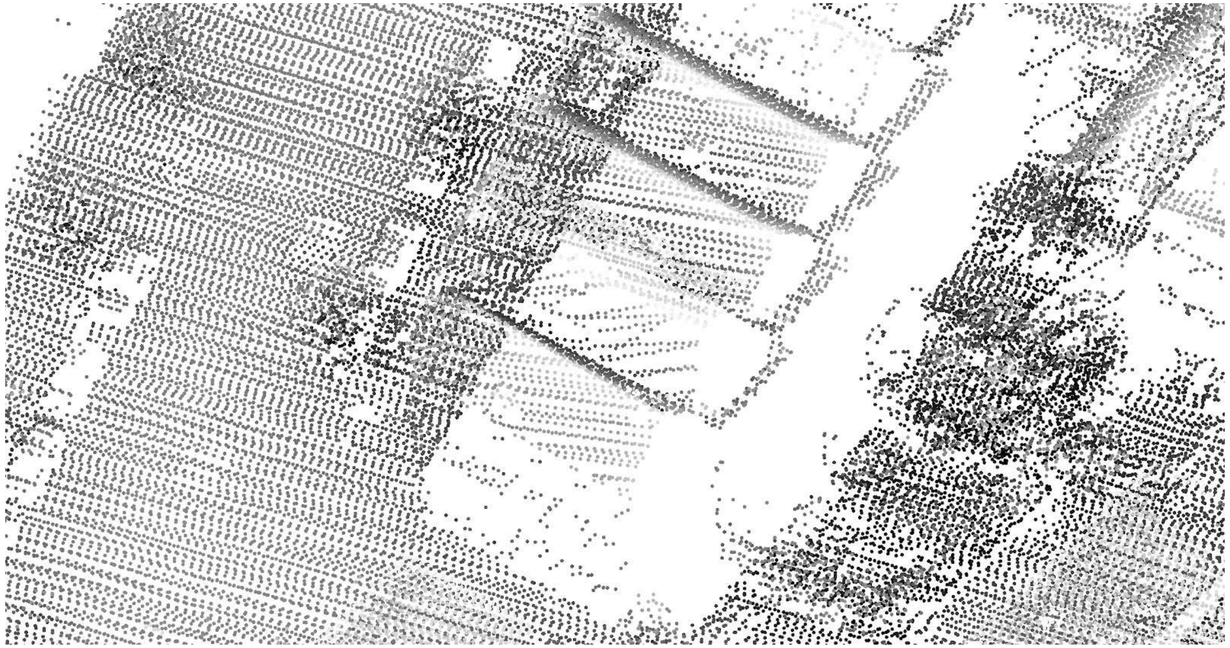
Creation of 3D city models

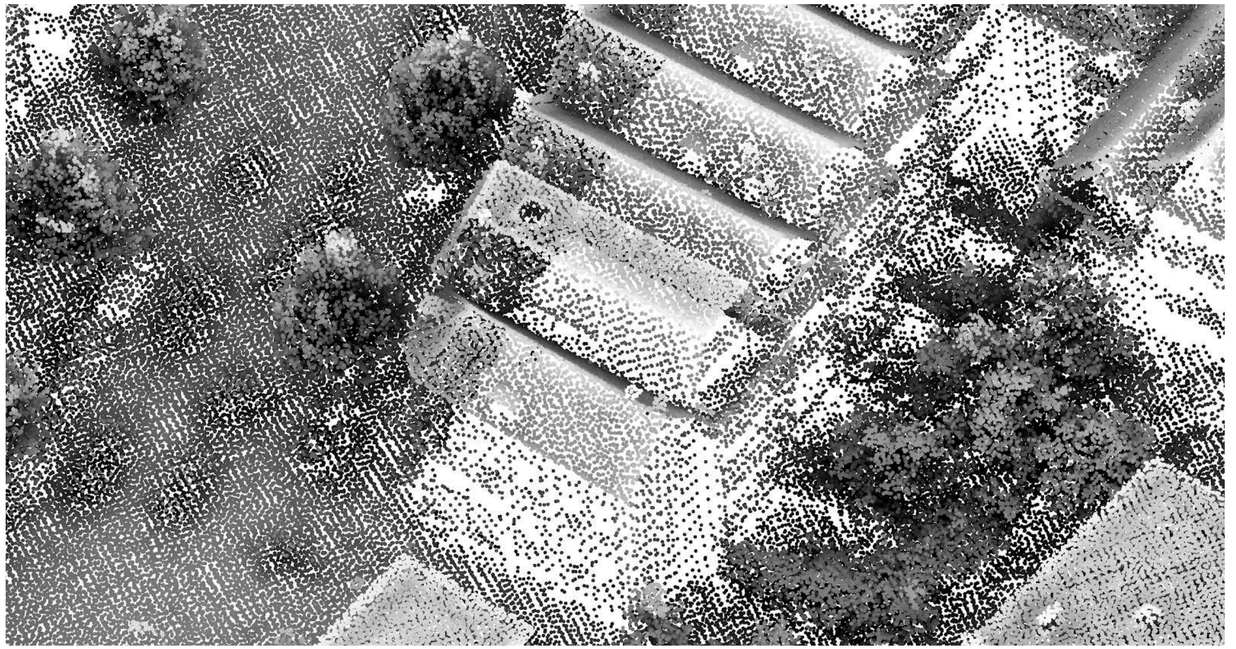
- **Aim**: construct semantic 3D models for different classes, e.g. buildings, roads, terrain, water bodies, etc.
- Buildings are usually the main focus
- The method and requirements can be different depending on the class and individual object, such as:
  - individual buildings and roads modelled in high detail
  - simplified terrain
  - no water bodies

Usual requirements

- **Low complexity:** the model ought to have as few vertices, edges, and faces as possible. Models with lower complexity are faster to process and take up less storage space.
- **High accuracy:** the surfaces of the model should have the lowest possible error with respect to the input.
- **Geometrically valid:** the mesh is 2-manifold, has consistent face orientation, no duplicate vertices, and no self-intersecting geometries.
- **Level of Detail (LoD):** a given degree of generalisation in the geometry of the reconstructed model compared to the actual real-world object.

Requirements: point density





Requirements: complex urban environments



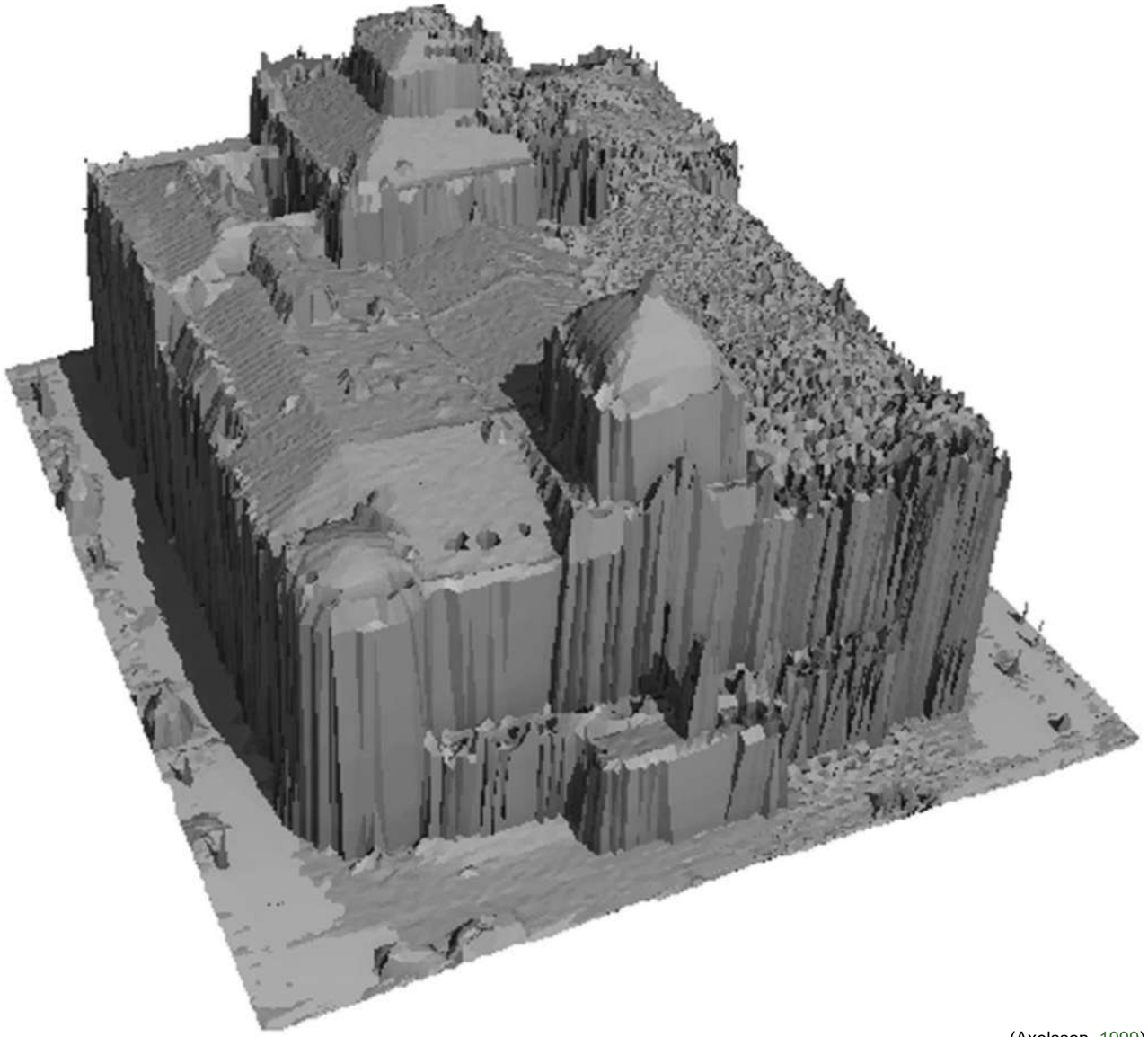
Creation of 3D city models

Two broad approaches (ends of a spectrum):

- **Data-driven**: Create a detailed model that perfectly matches the input data. Problems in the input data will cause problems in the model, e.g. holes from occluded areas and buildings that include nearby trees.

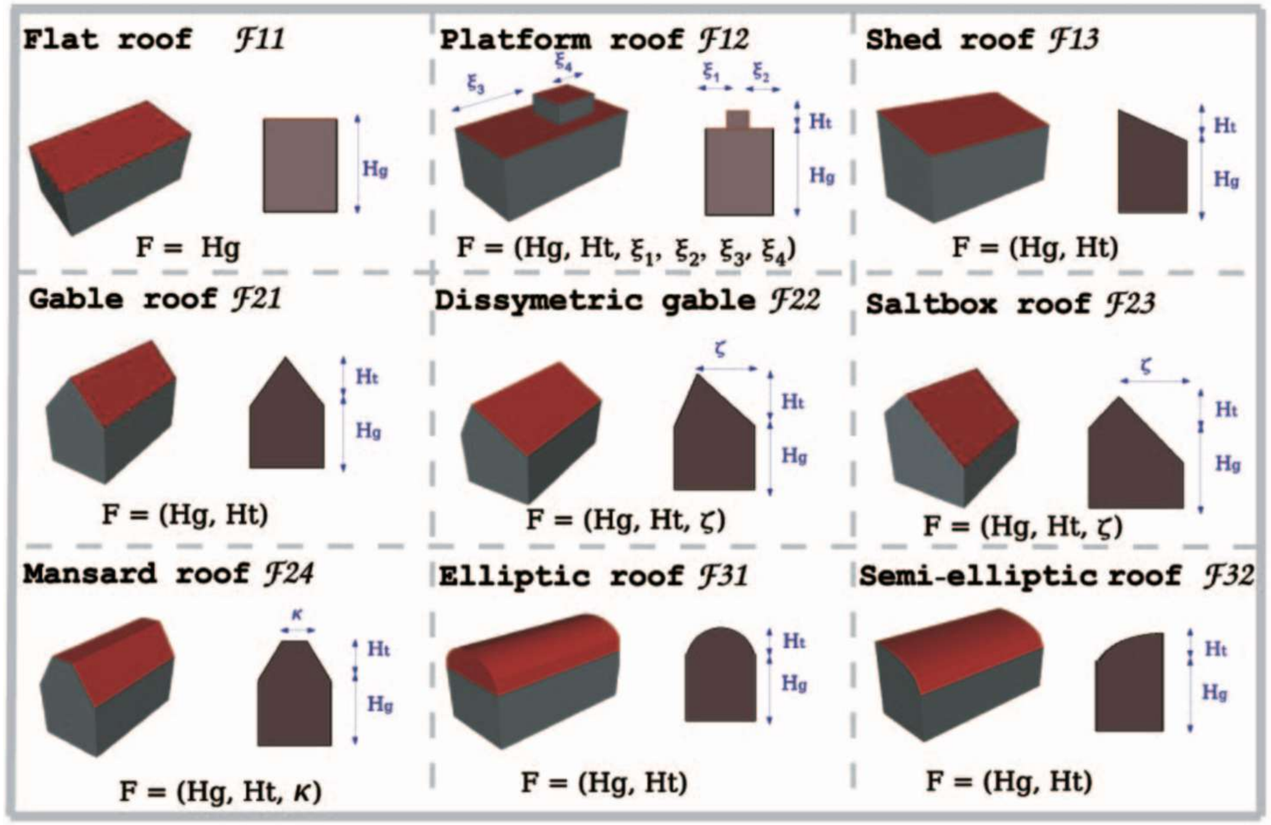
- **Model-driven**: Define rules to create models based on predefined types. Models won't fit the data as closely and will be less detailed, but problems in the input data (e.g. low point density or occlusion) can be more easily managed.

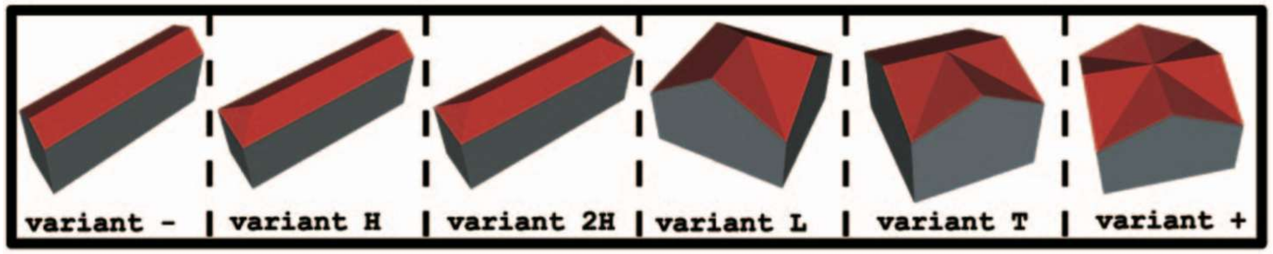
Creation of 3D city models: data-driven approach



(Axelsson, 1999)

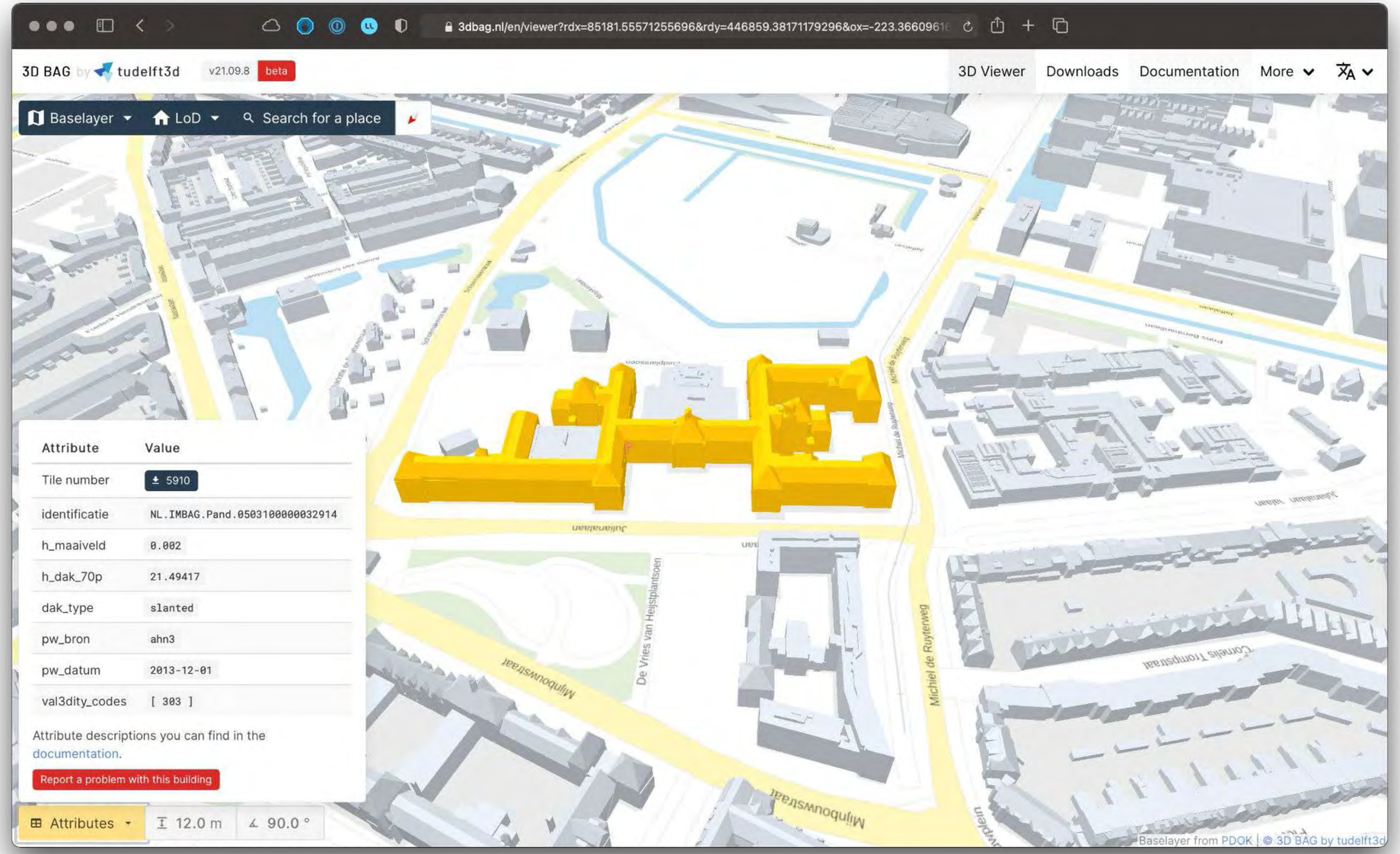
Creation of 3D city models: model-driven approach





(Lafarge et al., 2010)

Example: 3D BAG







Example: 3D BAG

- 3D city model covering all 10 million buildings in the Netherlands
- Multiple formats: CityJSON, GeoPackage, OBJ, etc.
- Open data created from other open data:
  - BAG building footprints
  - AHN point cloud
- Mixed approach: partly data-driven and partly model-driven

Example: 3D BAG

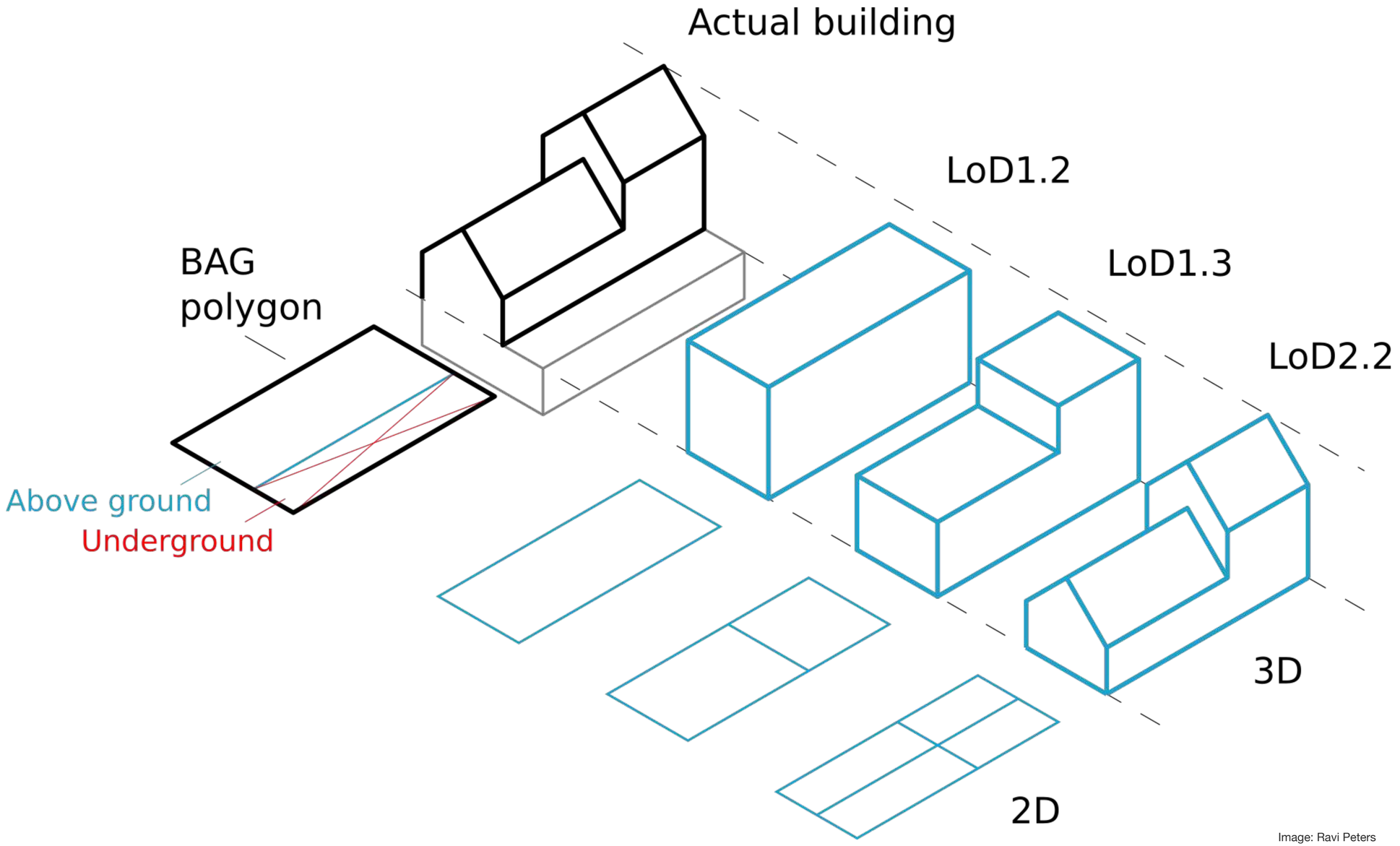
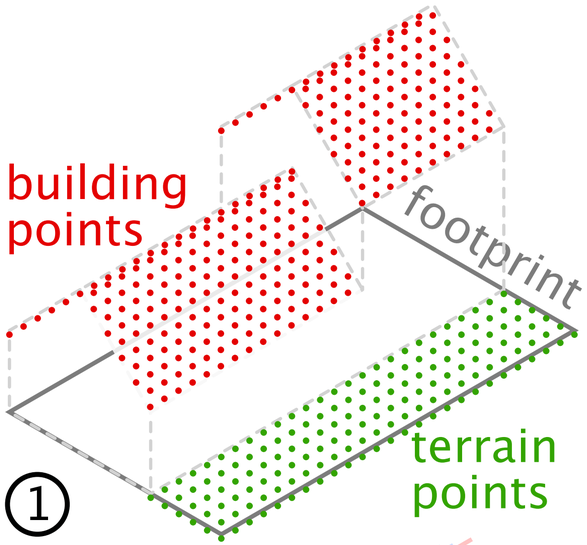
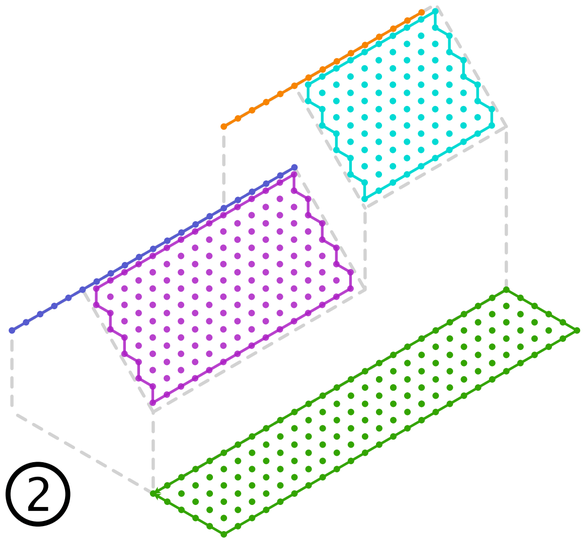


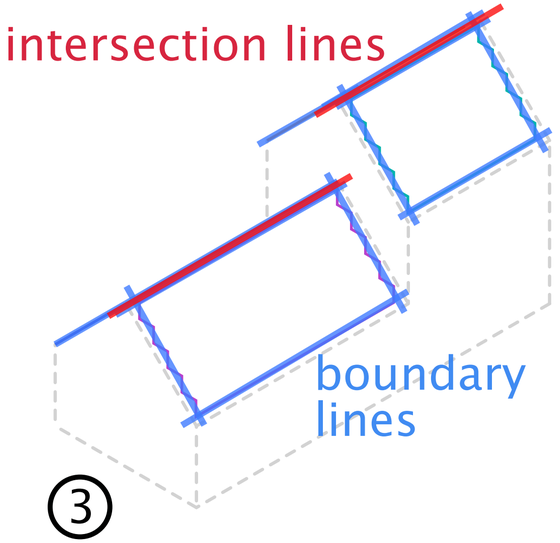
Image: Ravi Peters

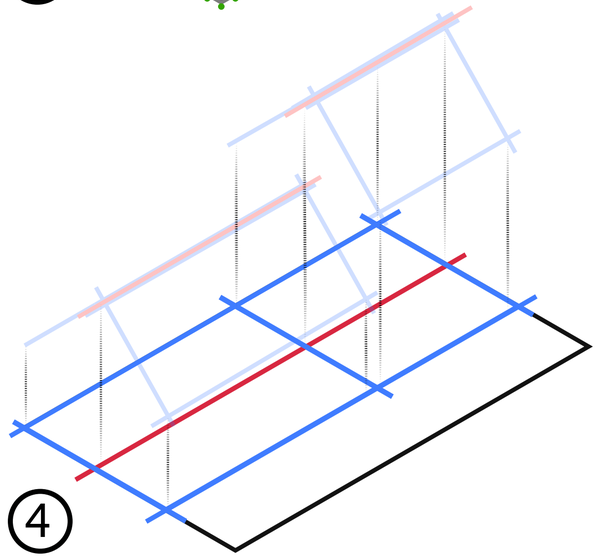
3D BAG: modelling assumptions

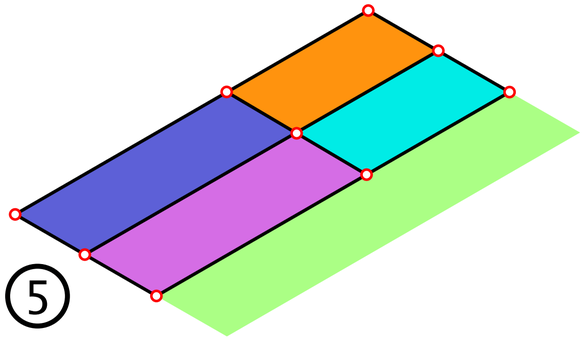
- **Piecewise planar:** The shape of a building can be adequately approximated using planar faces that are detectable from the point cloud.
- **2.5D with vertical walls:** The roof of the building is 2.5D and all walls are vertical. This implies the 3D building model can be extruded from a 2D planar partition of the roof.
- **Classified point cloud:** A reliable classification of the input point cloud is expected with least a building and a terrain (ground) class.
- **Footprints are available:** Apart from a point cloud, the method also takes 2D building footprints as input. It is assumed that the footprints are up-to-date and well aligned with the point cloud.

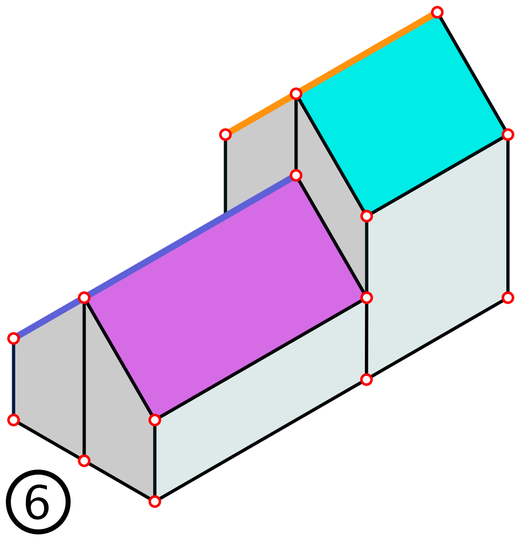

building points
footprint
terrain points
①


②

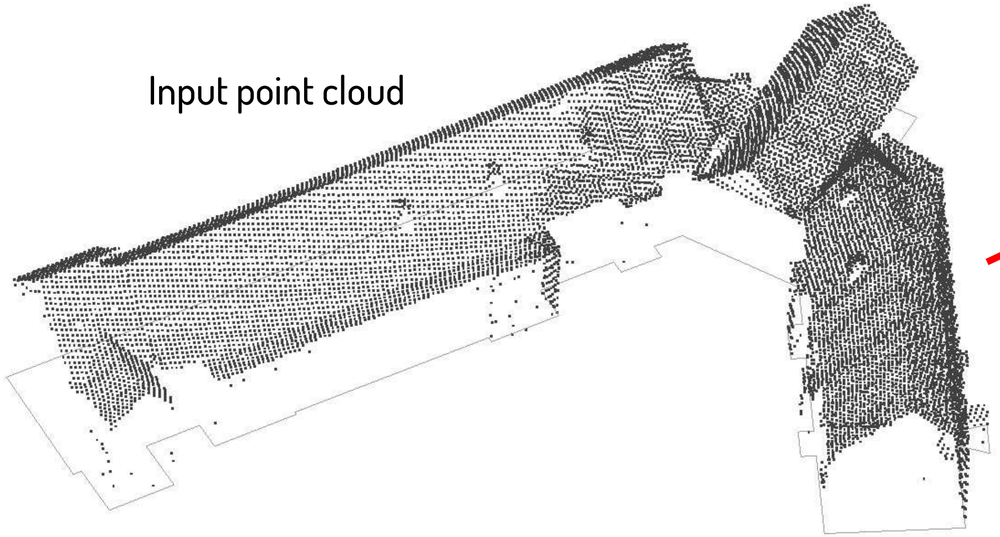

intersection lines
boundary lines
③


④

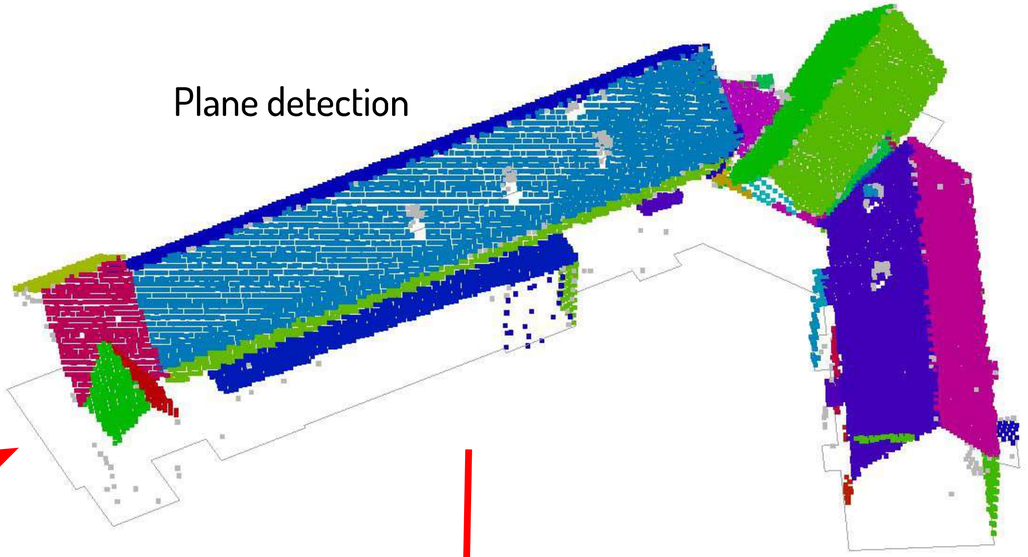

⑤


⑥

Input point cloud



Plane detection



Line detection

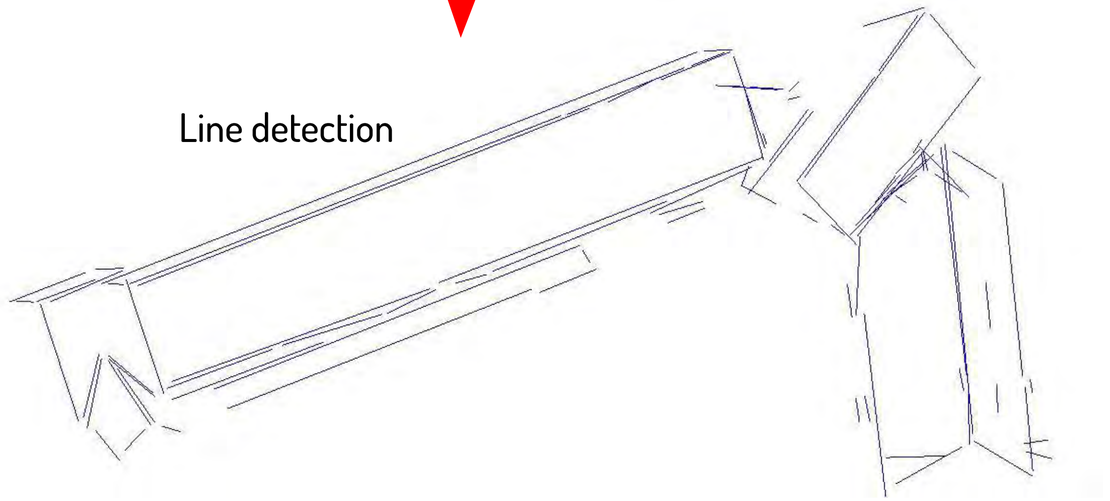
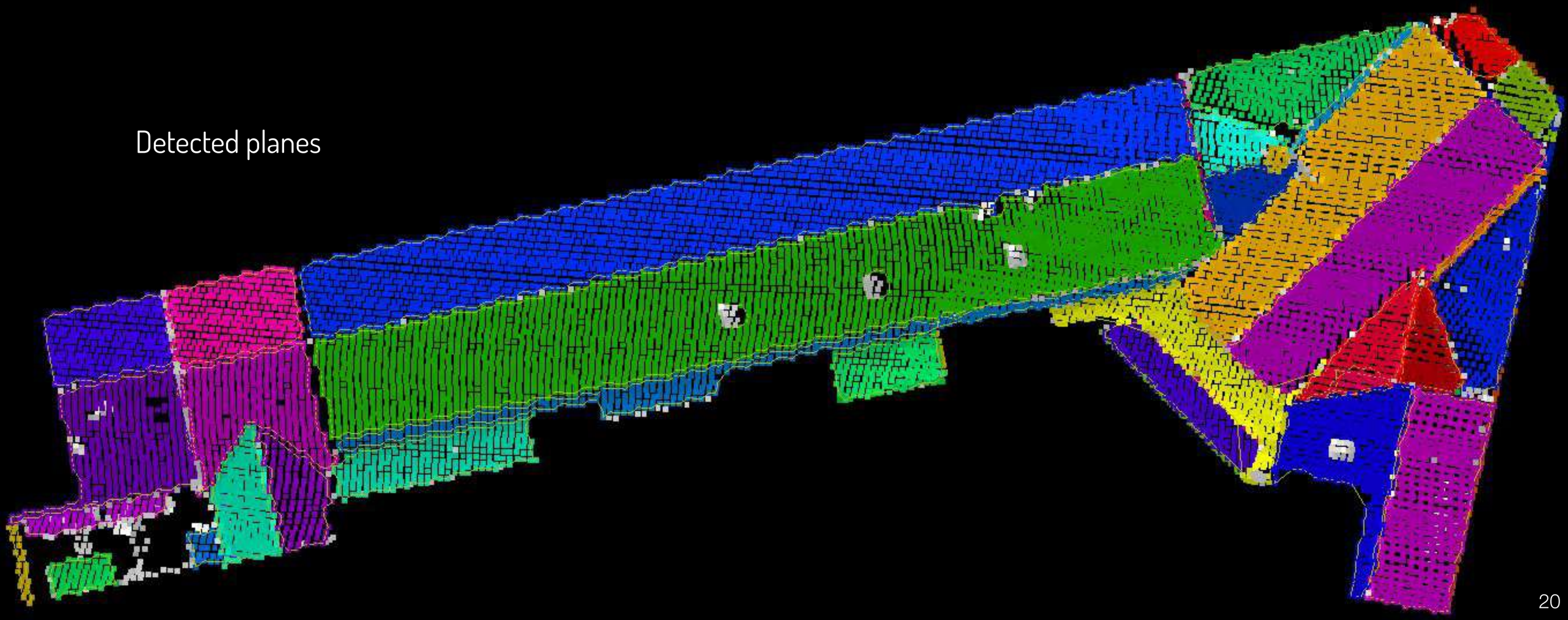


Image: Ravi Peters

3D BAG

Image: Ravi Peters

Detected planes



3D BAG

Image: Ravi Peters

α-shape

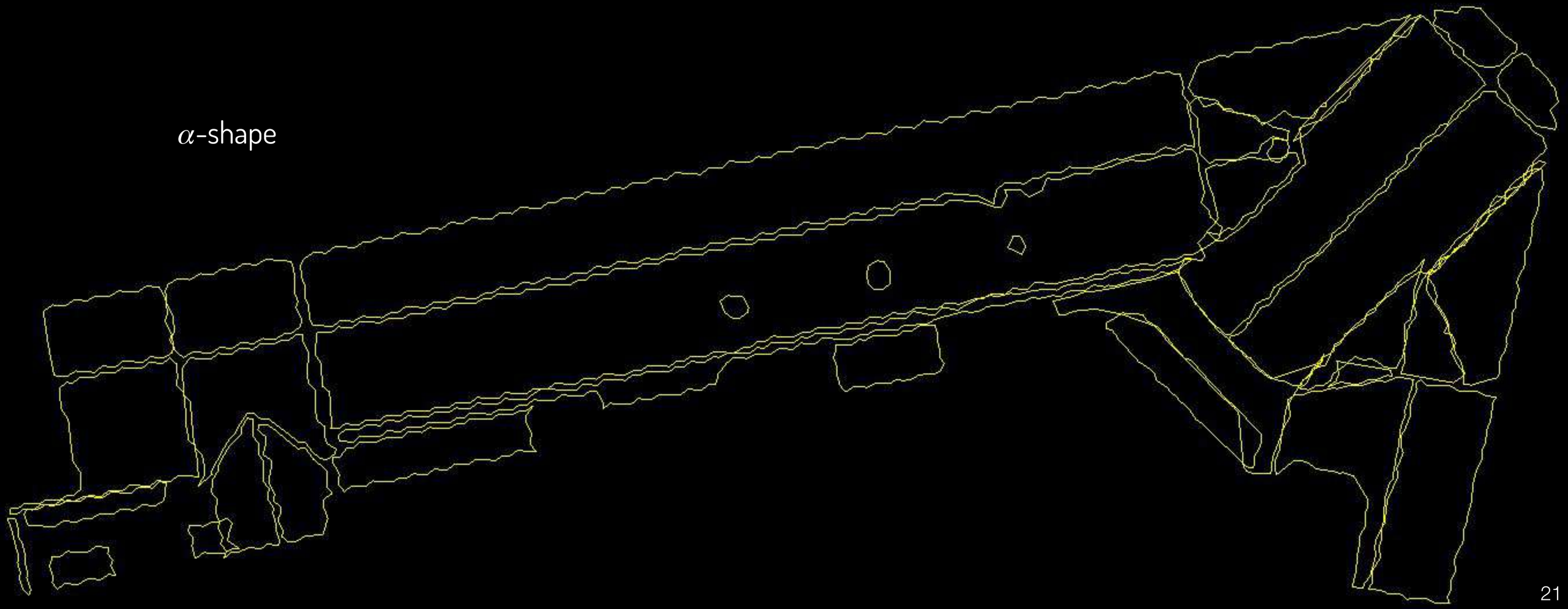
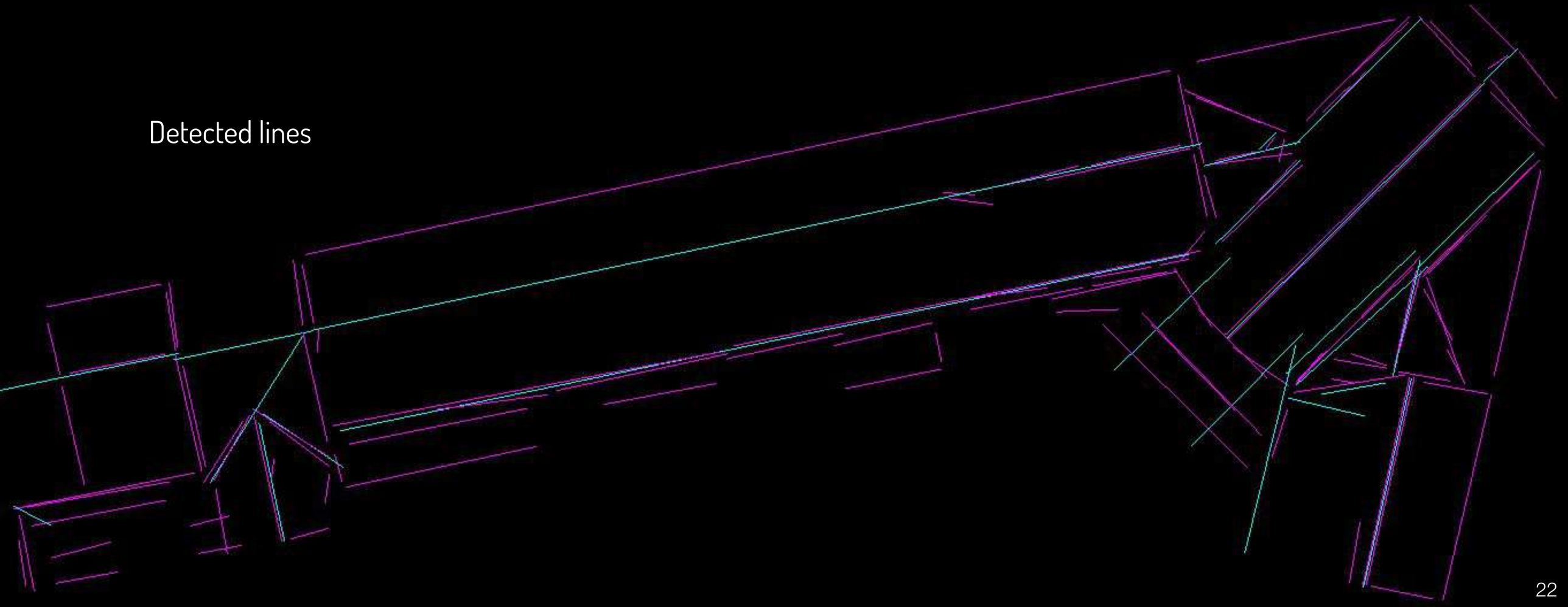
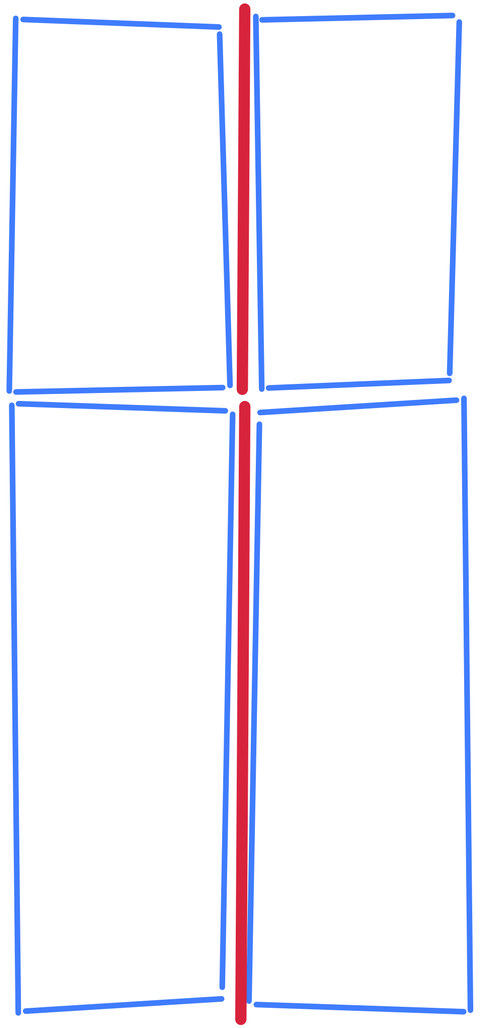


Image: Ravi Peters

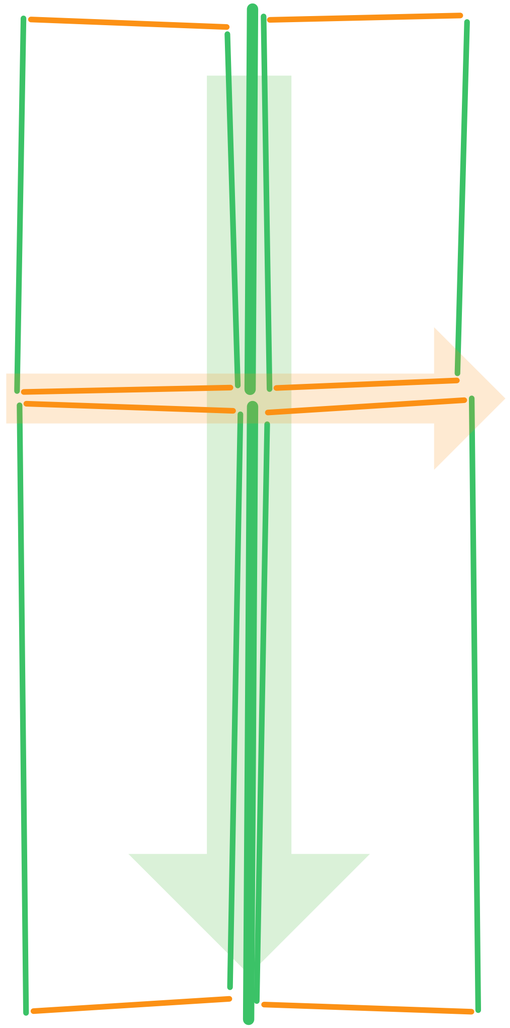
Detected lines



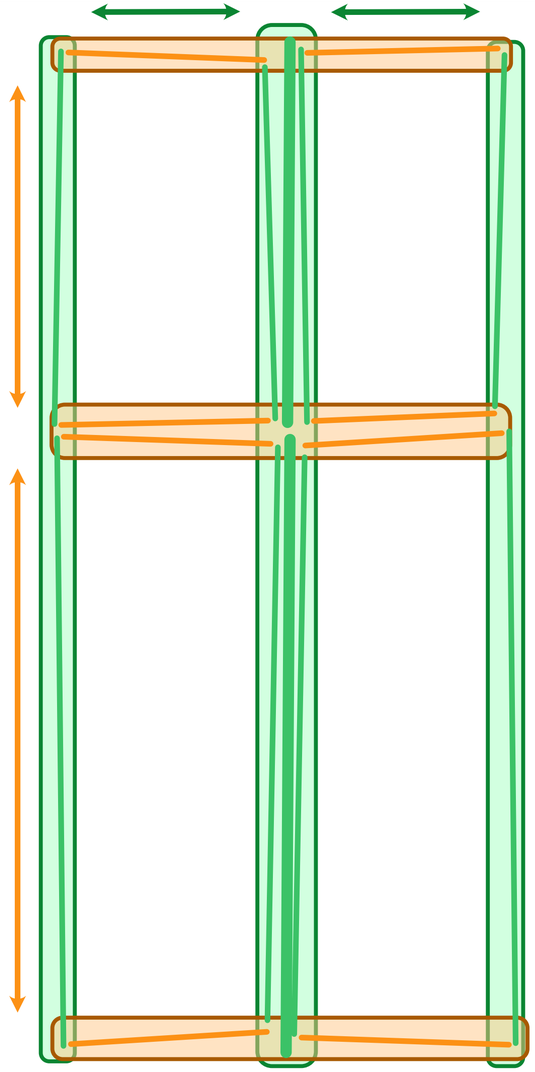
3D BAG: line regularisation



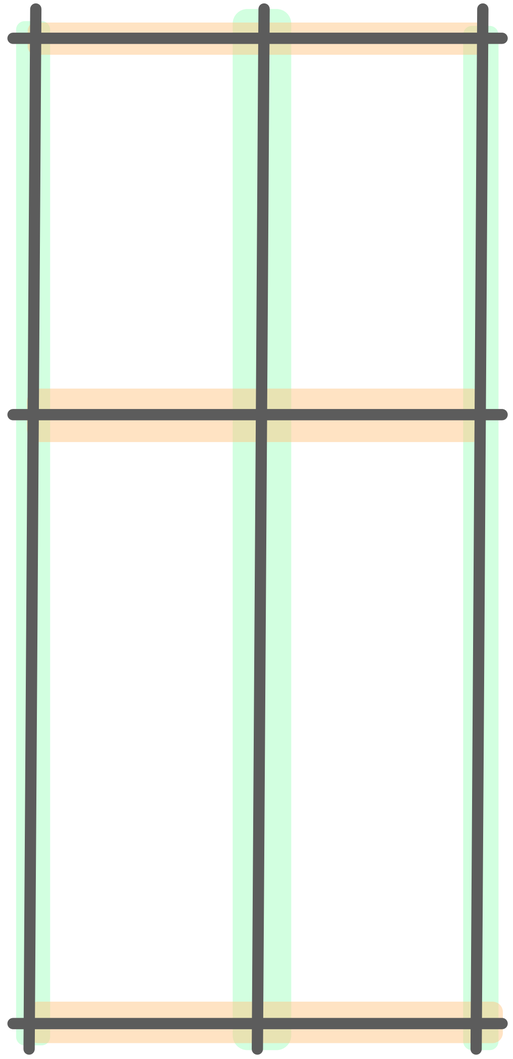
detected lines



orientation clustering



distance clustering



regularised lines

3D BAG: initial roof partition

- The regularised lines mostly form a planar partition, but there are some artefacts to fix:
  - very small faces, and
  - dangling edges.

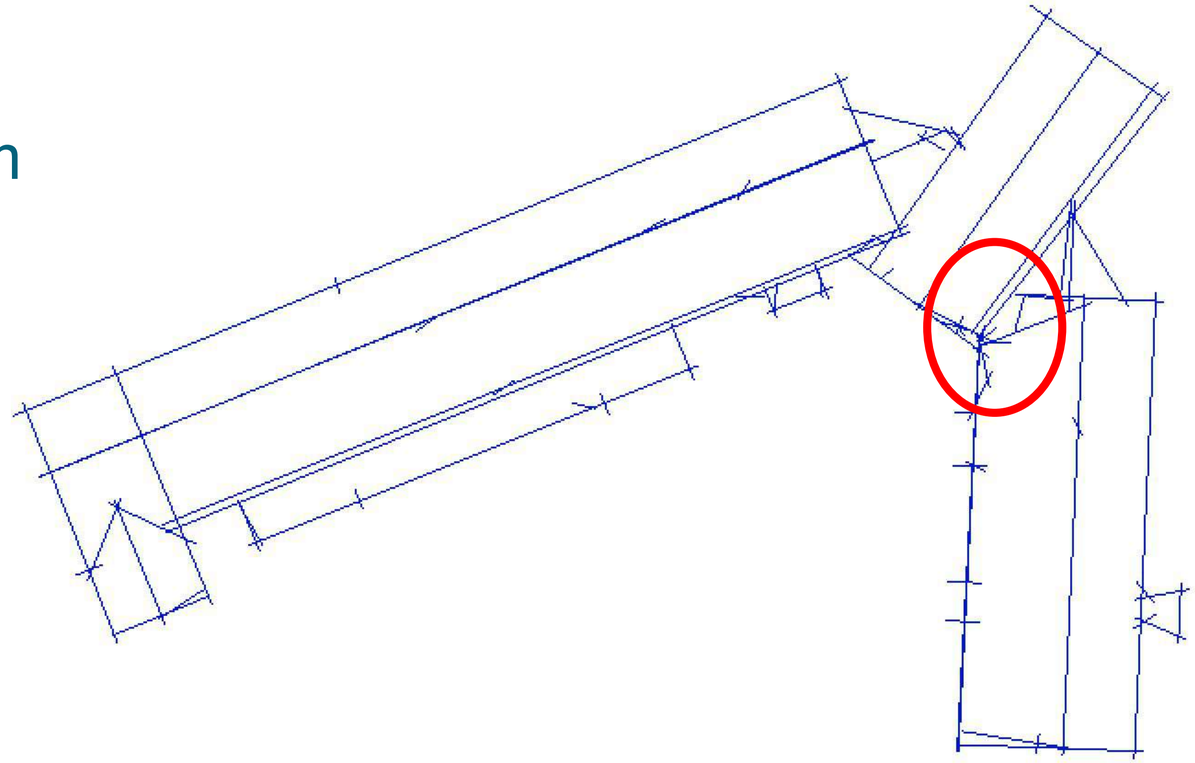
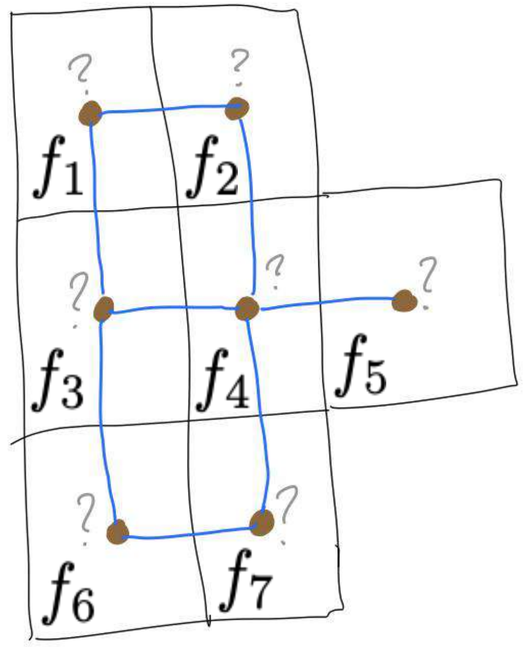


Image: Ravi Peters

3D BAG: roof partition optimisation

- In order to obtain a better roof partition, the dangling edges are removed and certain faces are merged.
- A dual graph of the original input faces is created, where faces are vertices and adjacent faces are joined by an edge.
- The edges in this graph represent potential faces that could be merged.

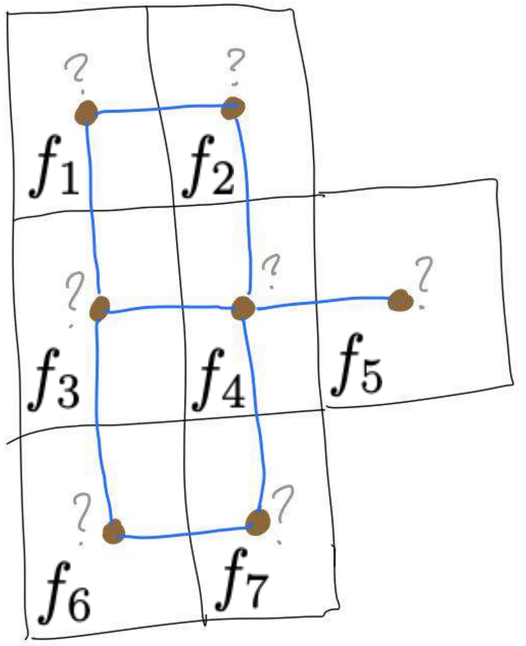
Dual graph of planar arrangement

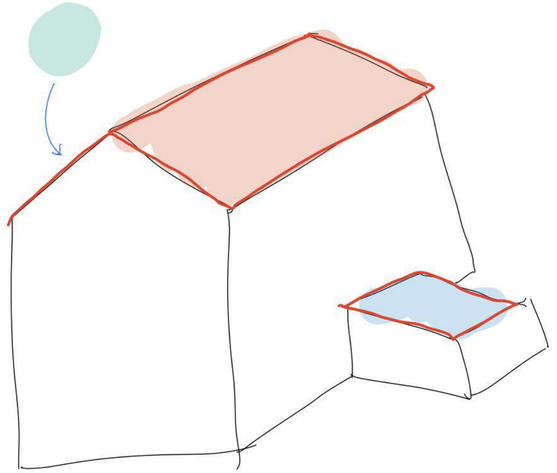


3D BAG: roof partition optimisation

- **Aim**: assign a plane label to each face, then merge adjacent faces that have the same label.
- This label is assigned by minimising a weighted sum of two opposing terms: a data term (data-driven) and a smoothness term (model-driven)

Dual graph of planar arrangement

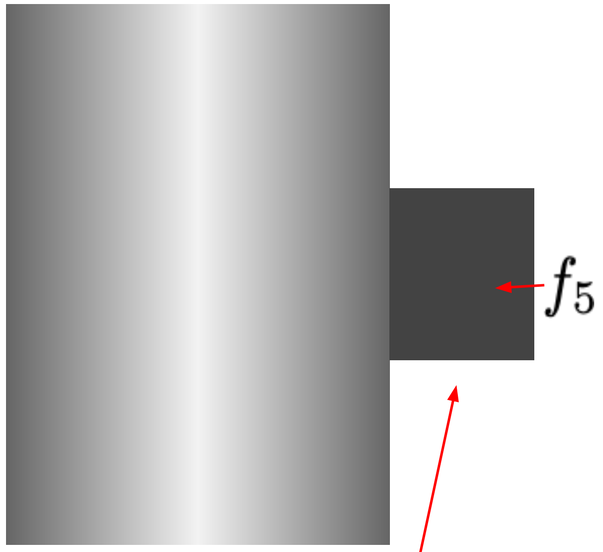


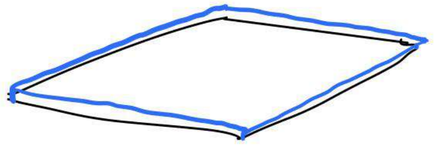


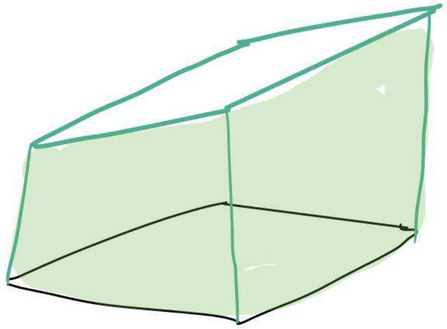


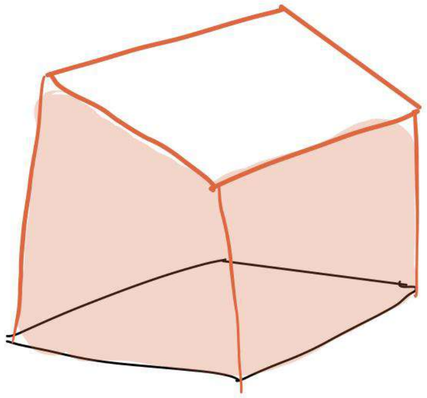
3D BAG: roof partition optimisation

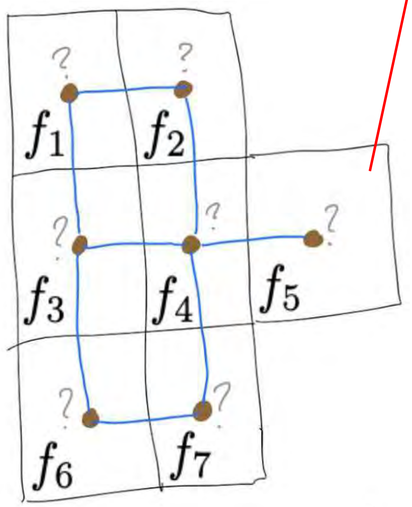
- The data term tries to pick the label that best fits the data.
- It is given by the volume between the 2.5D heightfield of the point cloud and the candidate labels' planes.





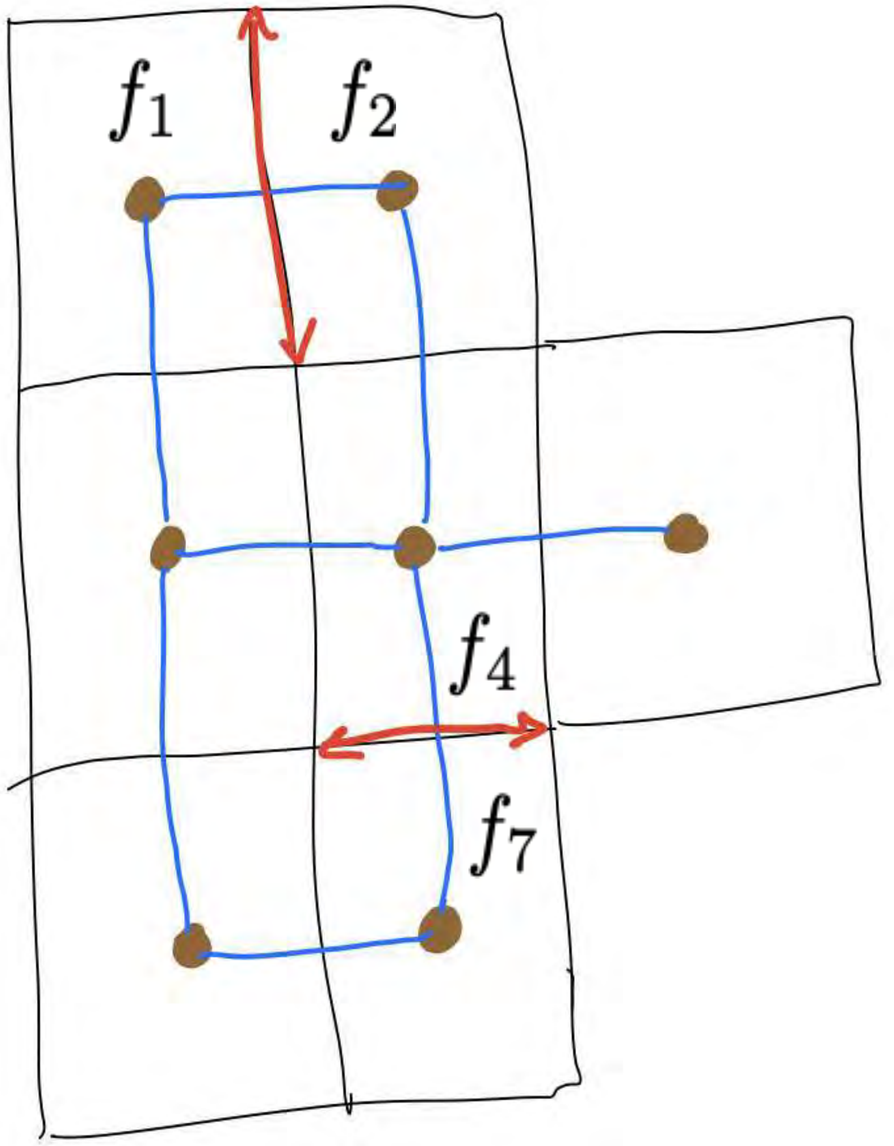




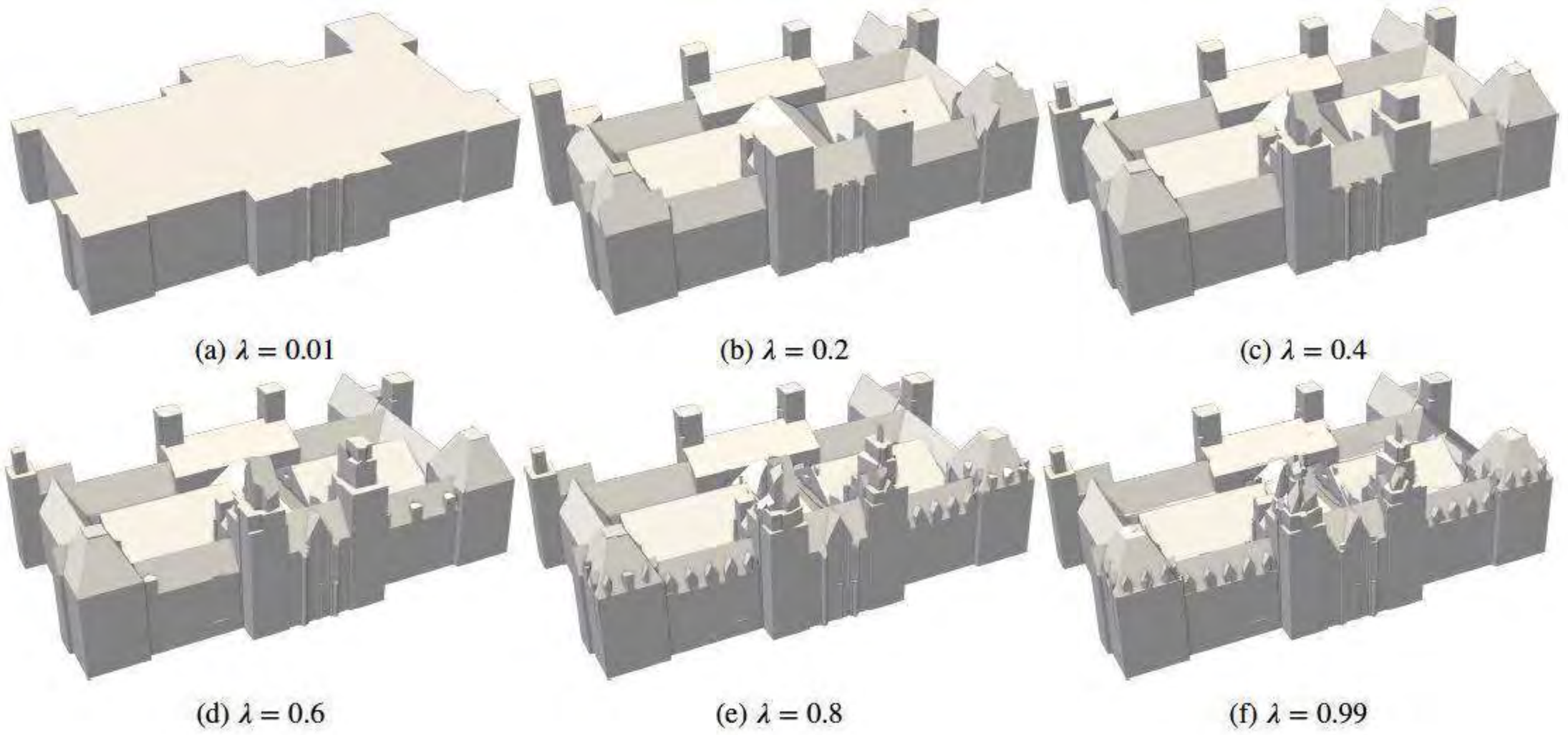


3D BAG: roof partition optimisation

- The smoothness term tries to merge adjacent faces. For a pair of adjacent faces, it is:
  - zero if the faces have the same label, and
  - the length of the common face if they do not.



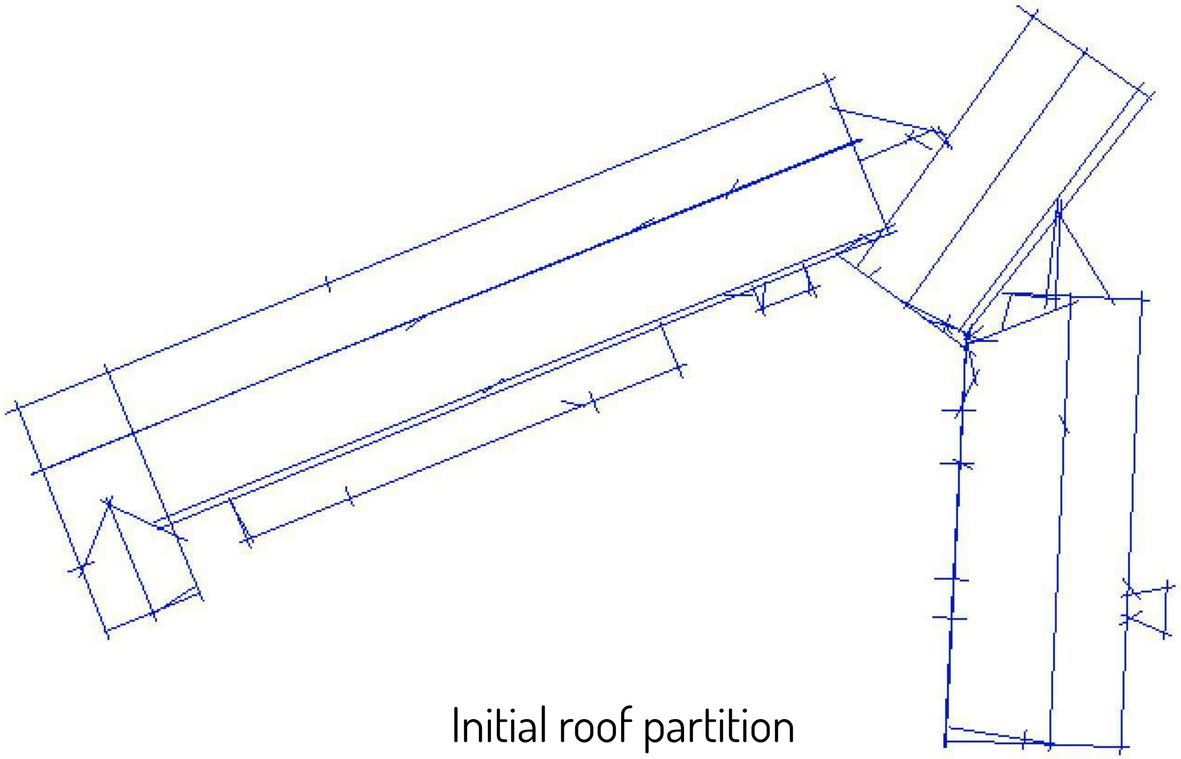
3D BAG: roof partition optimisation (weight)



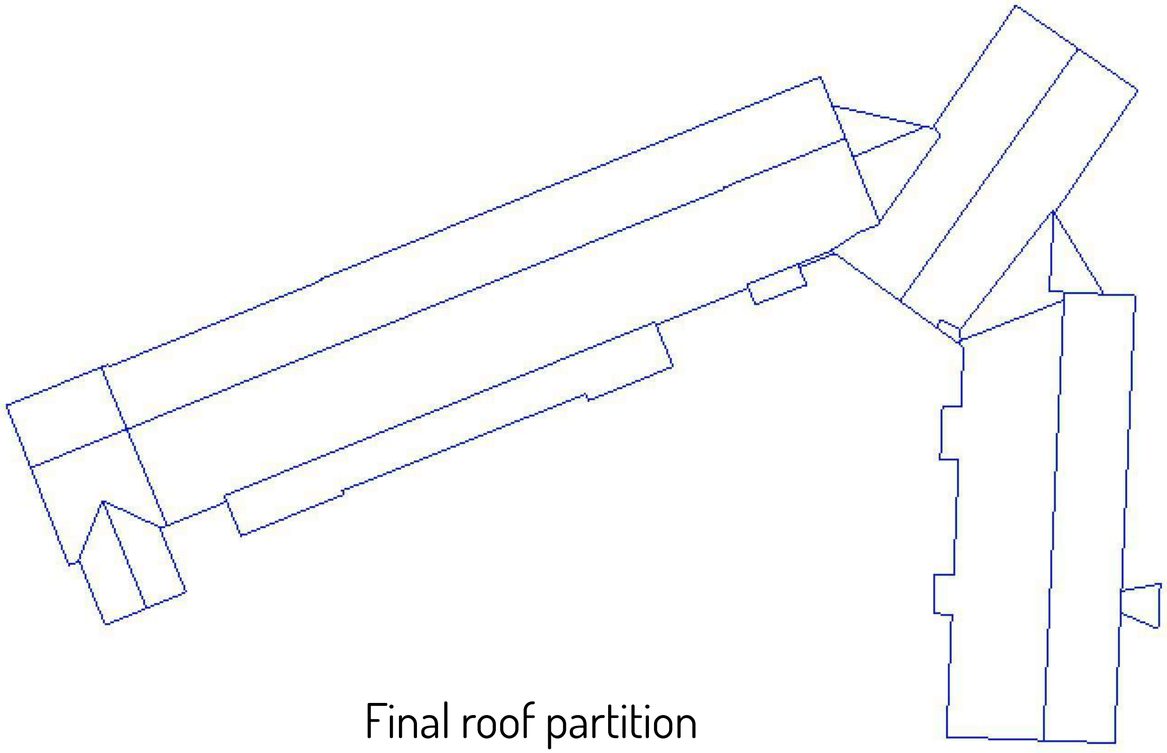
(a) $\lambda = 0.01$ (b) $\lambda = 0.2$ (c) $\lambda = 0.4$

(d) $\lambda = 0.6$ (e) $\lambda = 0.8$ (f) $\lambda = 0.99$

3D BAG: roof partition optimisation



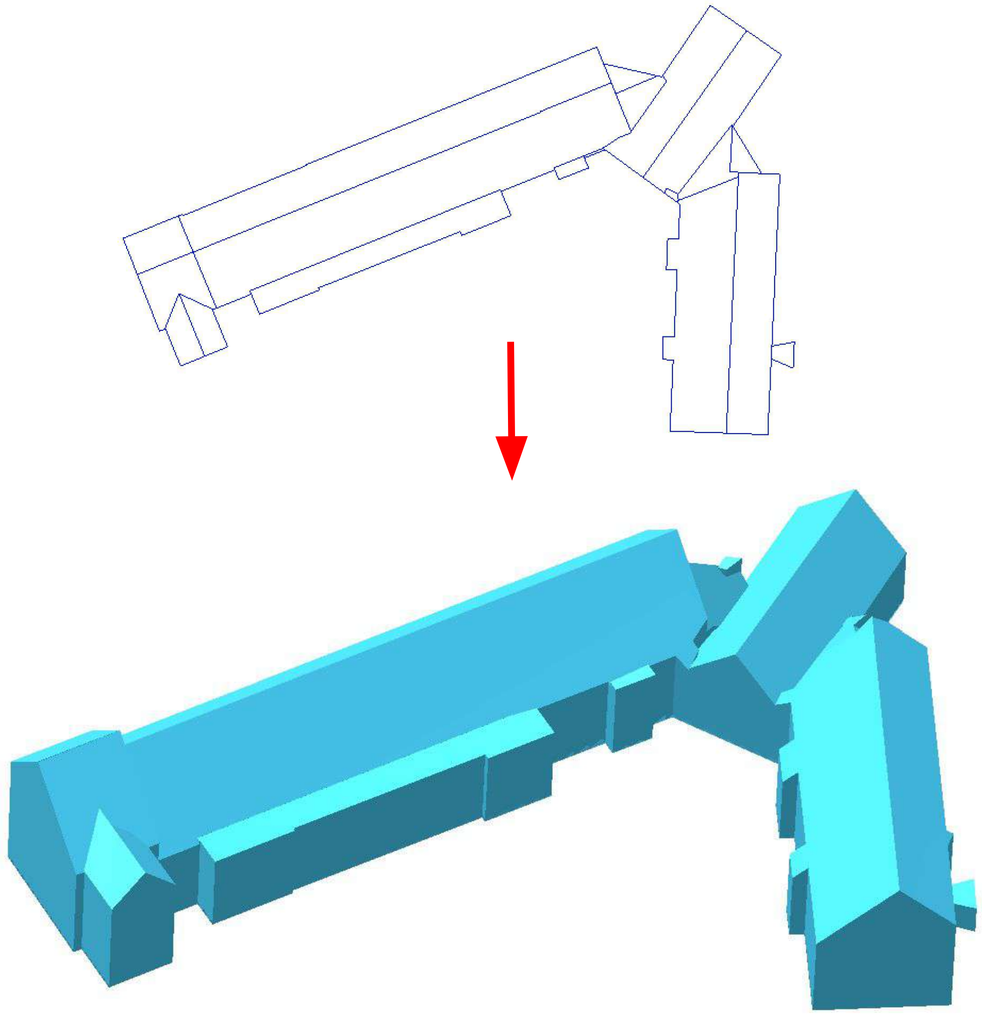
Initial roof partition



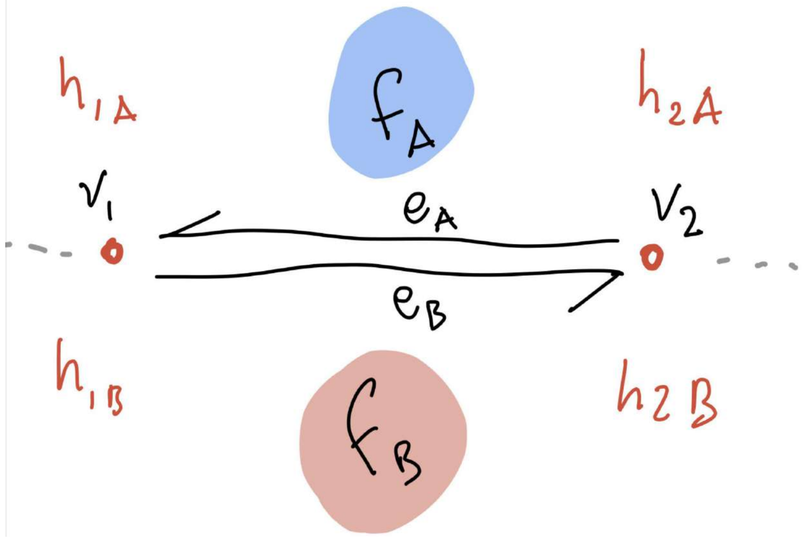
Final roof partition
(edges between equal plane labels dissolved)

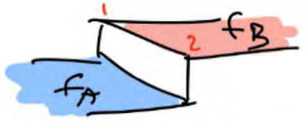
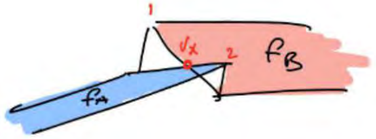
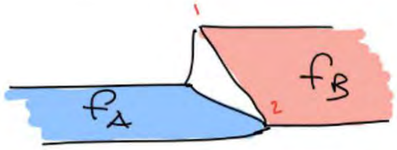
Image: Ravi Peters

3D BAG: extrusion



3D BAG: extrusion

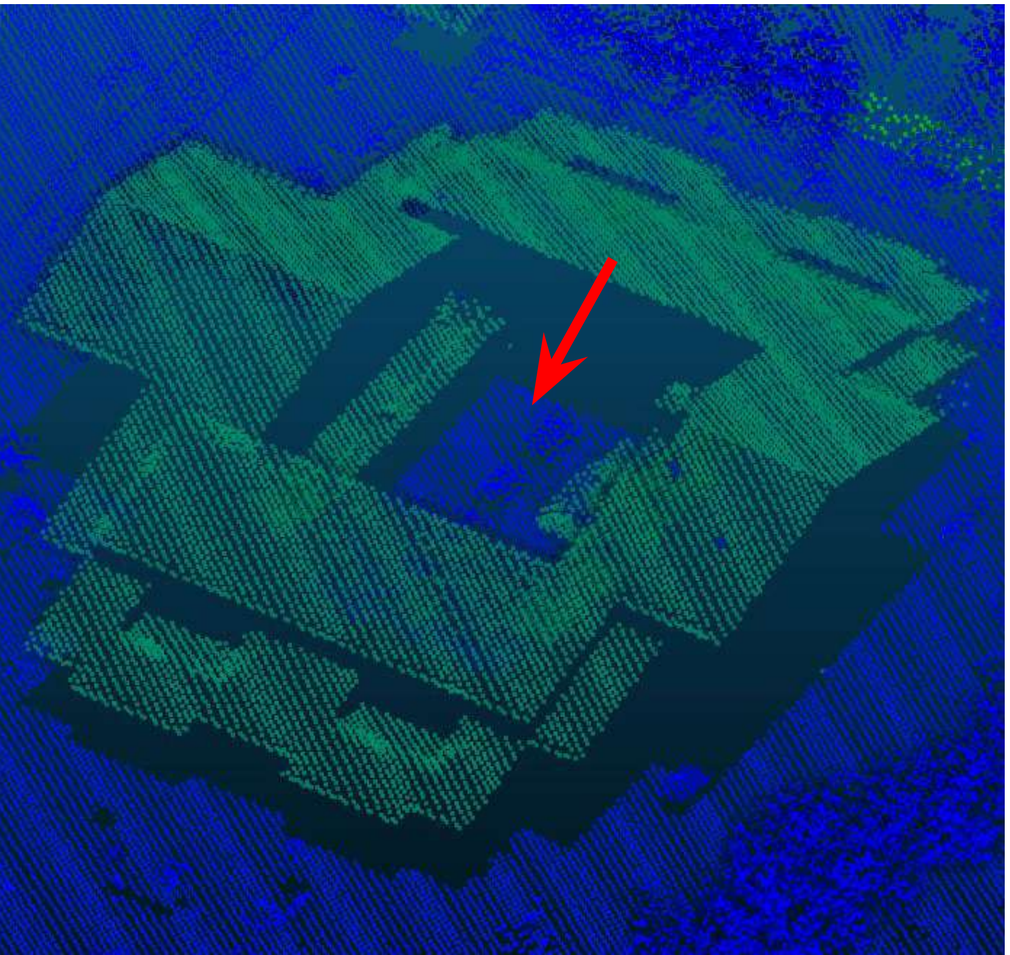


Case	condition	vertex order
	$h_{1A} < h_{1B}$ AND $h_{2A} < h_{2B}$	1. v_{1B}, v_{1A}, v_{2A}, v_{2B}
	$h_{1A} < h_{1B}$ AND $h_{2A} > h_{2B}$	1. v_{1B}, v_{1A}, v_x 2. v_{2A}, v_{2B}, v_x } 2 faces!
	$h_{1A} < h_{1B}$ AND $h_{2A} == h_{2B}$	1. v_{1B}, v_{1A}, v_{2A}

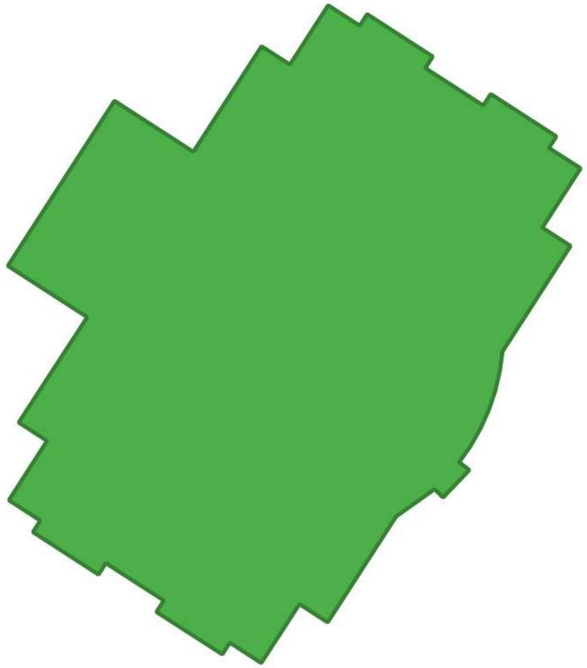
3D BAG: challenges

In some cases BAG footprint includes groundparts

AHN3 ground and building class



BAG footprint



Reconstruction result:
roofplane fitted to groundpart

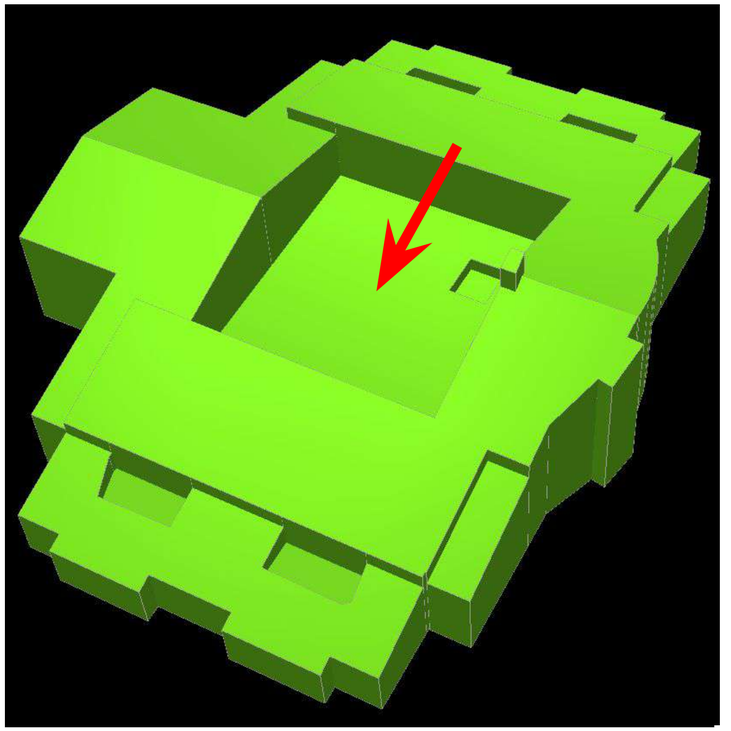
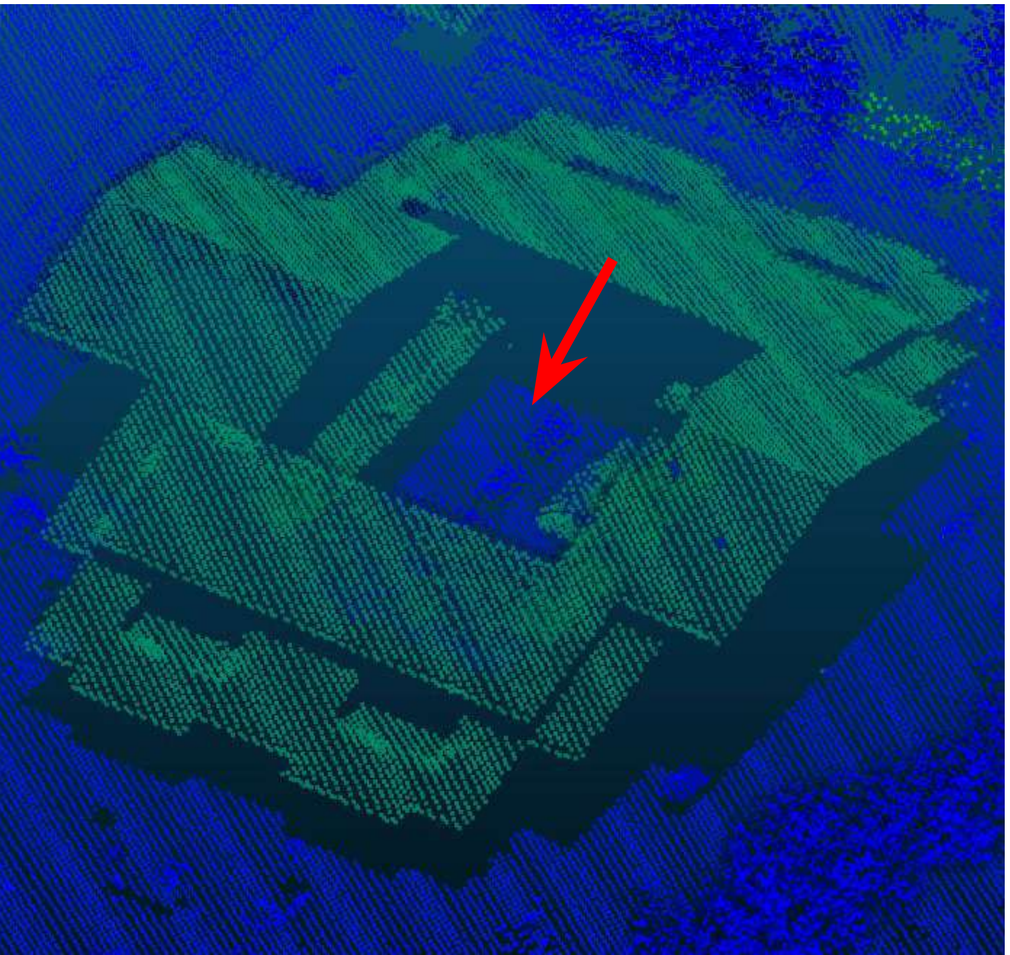


Image: Ravi Peters

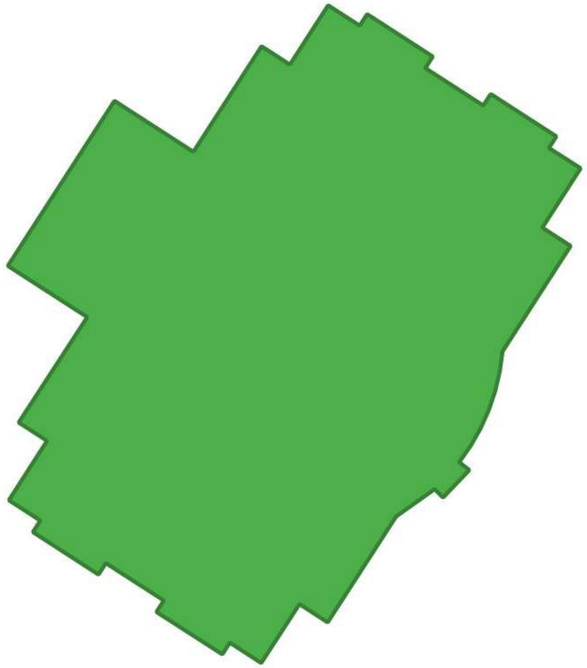
3D BAG: challenges

Reconstruction with groundpart detection

AHN3 ground and building class



BAG footprint



Reconstruction result:
groundpart removed from output

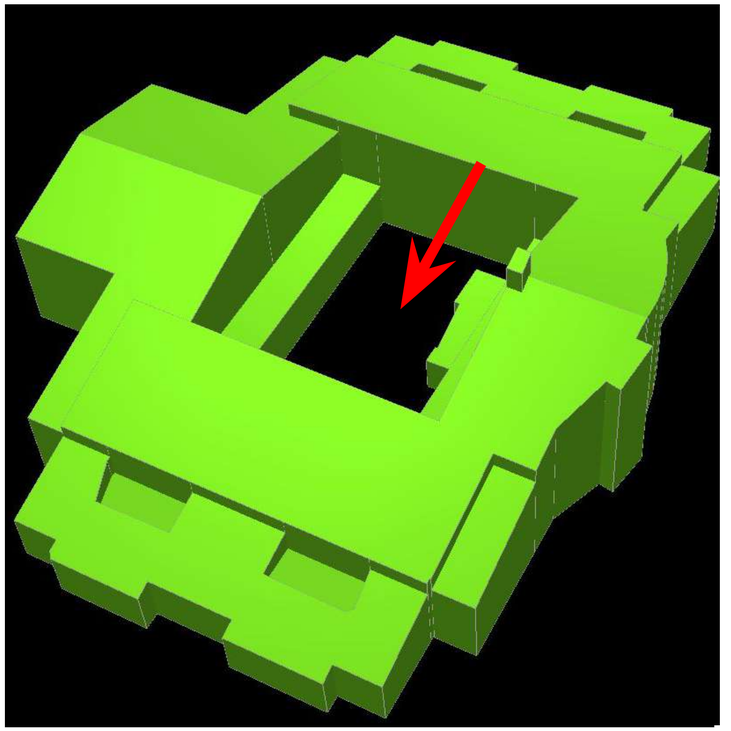


Image: Ravi Peters

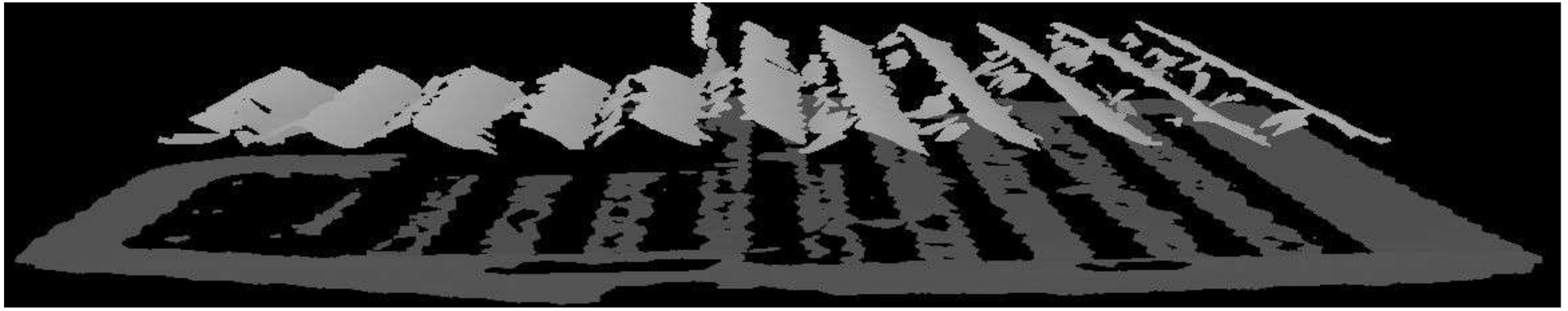
3D BAG: challenges



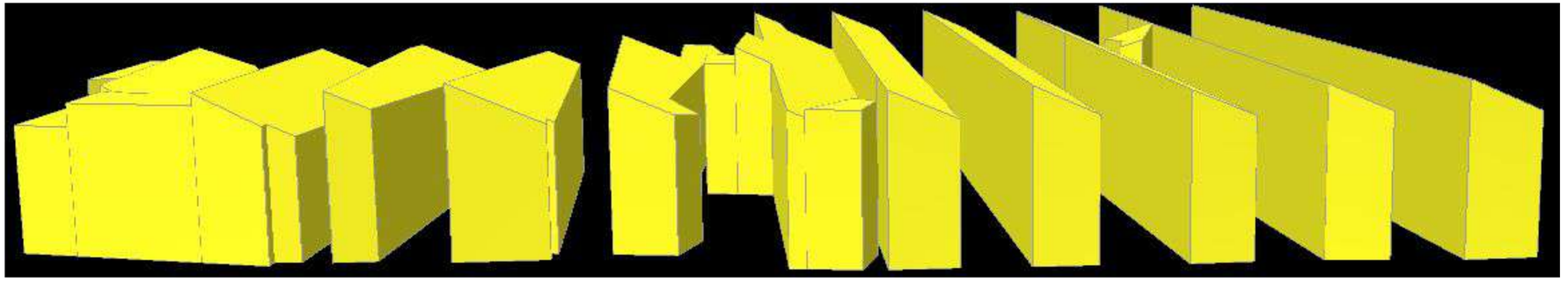
3D BAG: challenges



AHN3
ground and building class



Heightfield



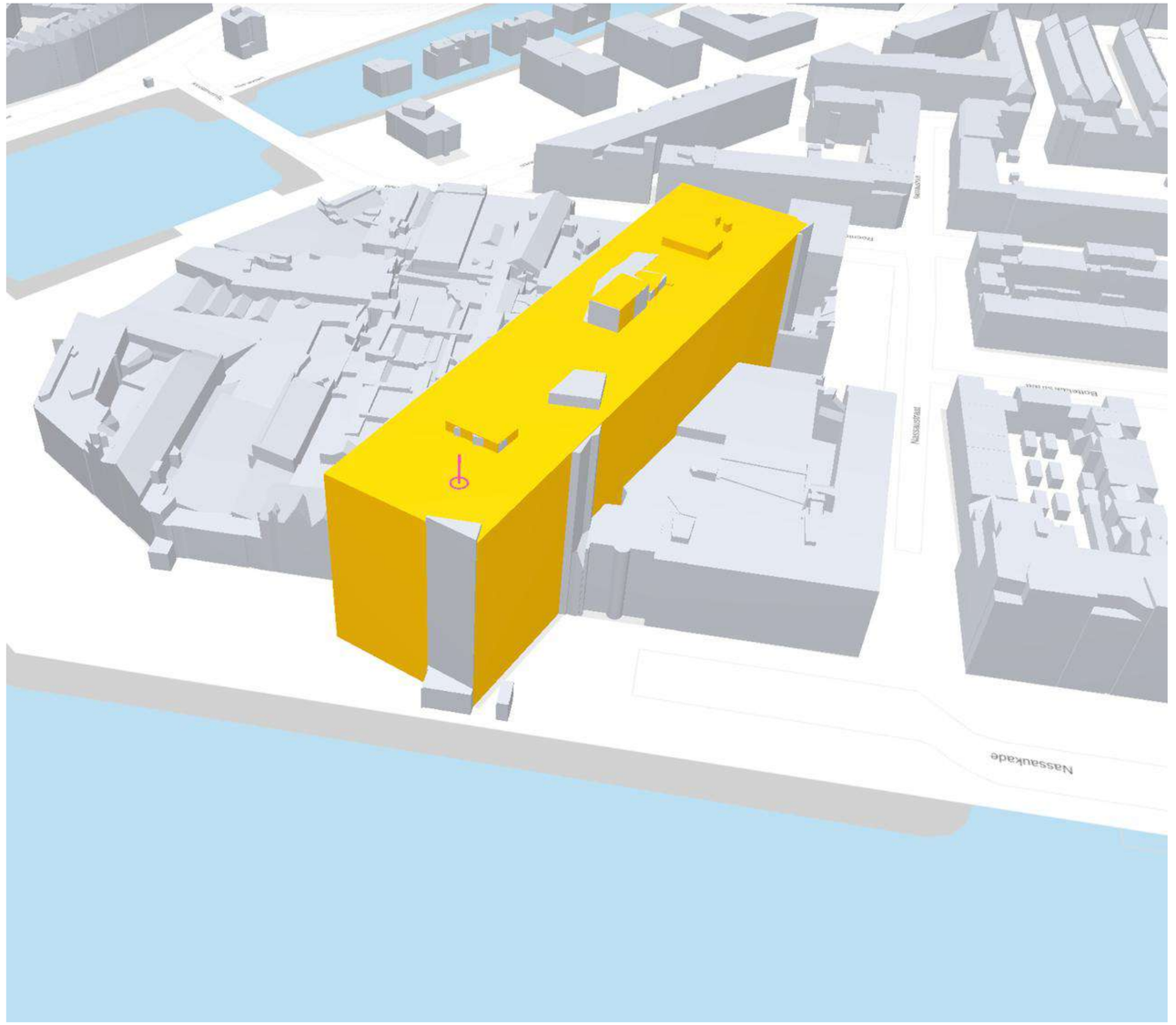
Reconstruction result

Image: Ravi Peters

3D BAG: challenges



3D BAG: challenges



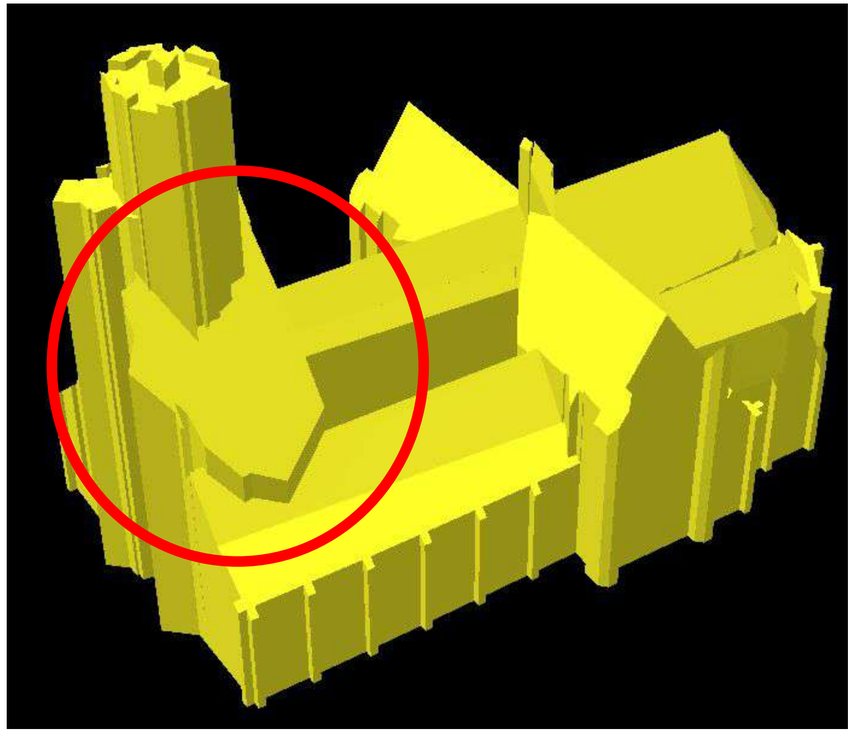
3D BAG: challenges



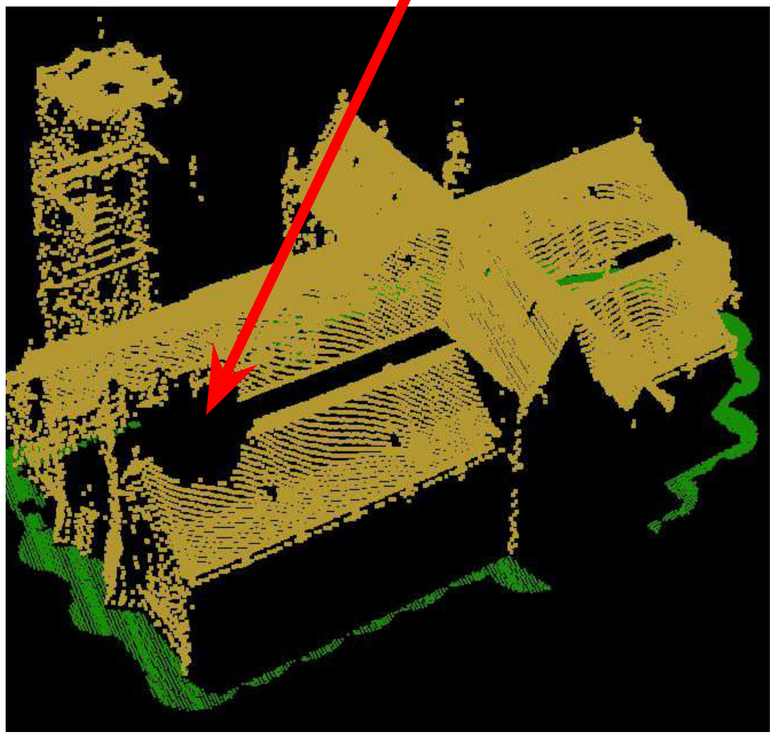
@tresdmartes

3D BAG: challenges

Occlusion/no-data



Reconstruction



AHN3 ground and building class



Heightfield

Image: Ravi Peters

3D BAG: challenges

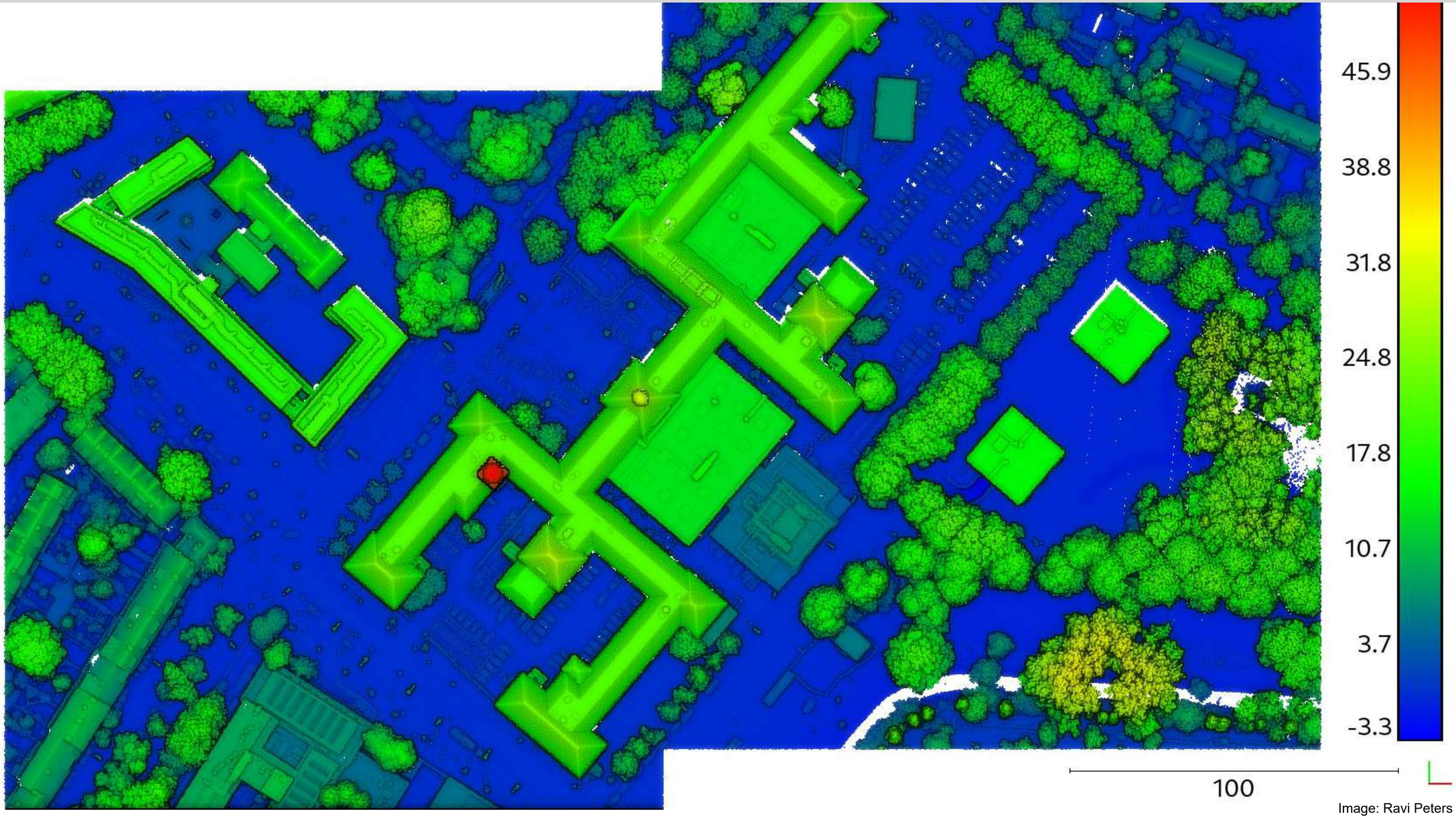


Image: Ravi Peters

3D BAG: challenges



Image: Ravi Peters

3D BAG: challenges

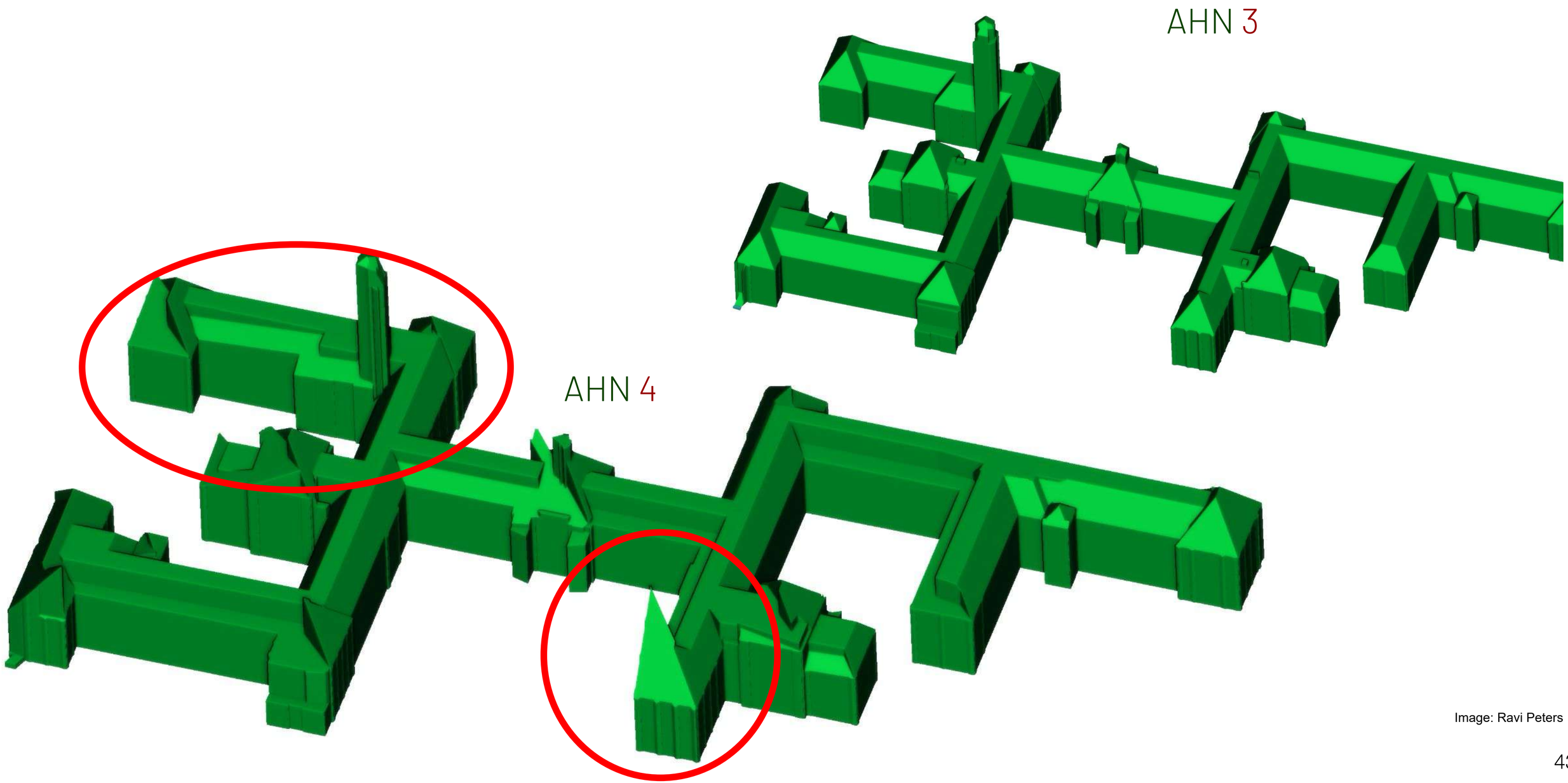
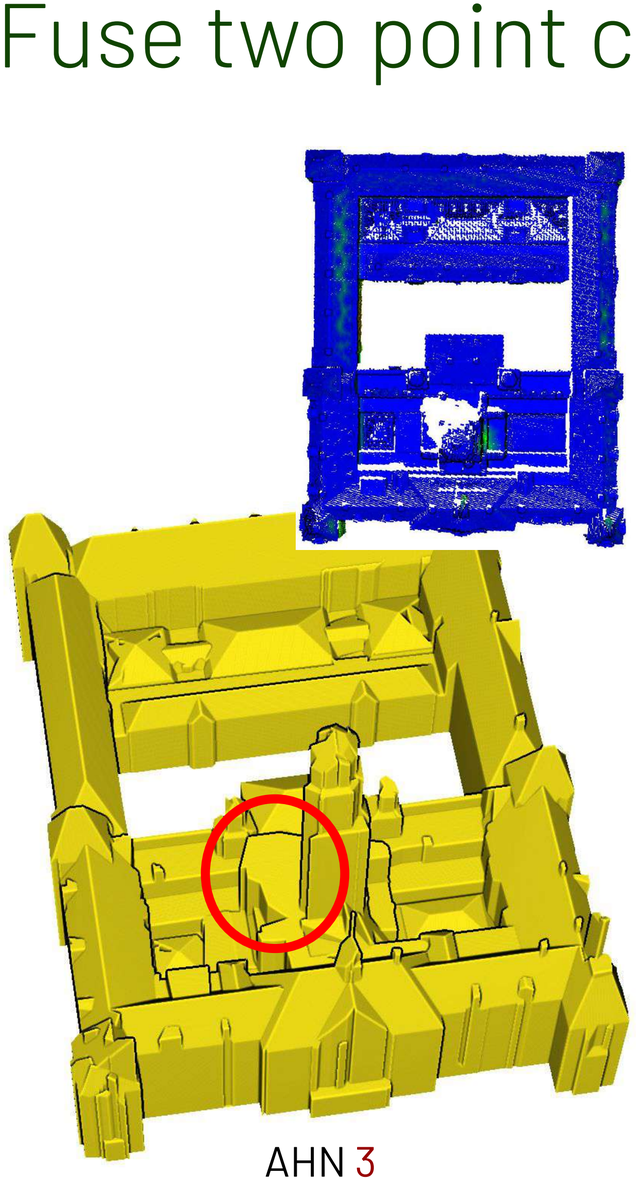
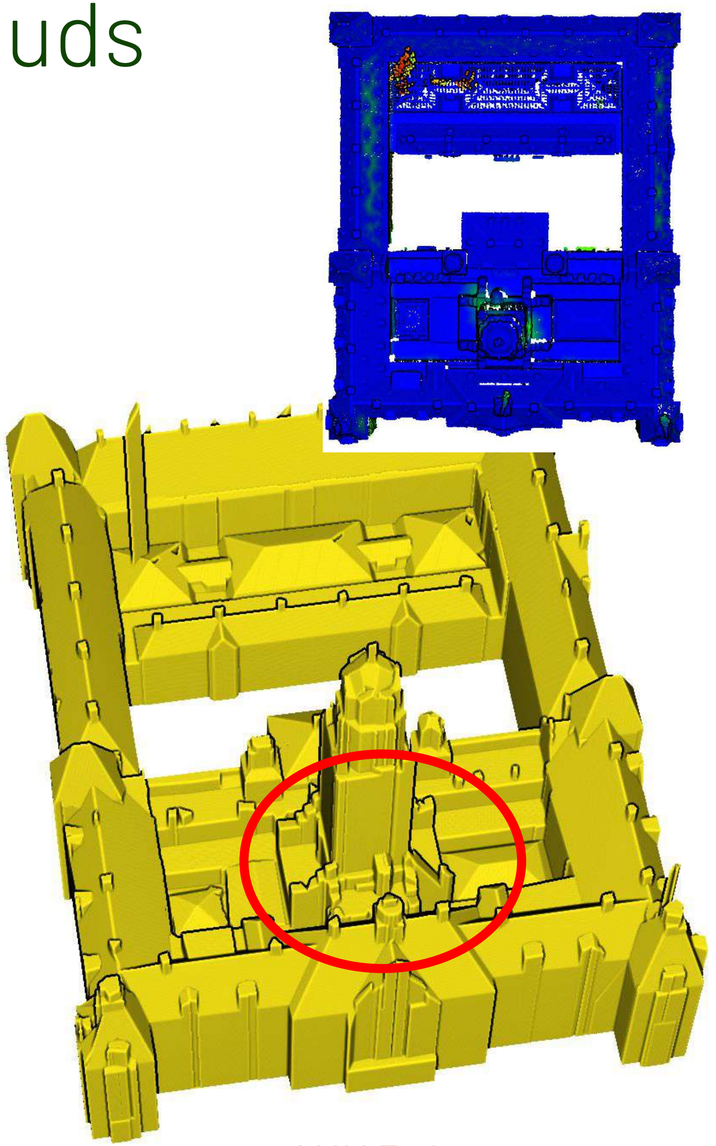


Image: Ravi Peters

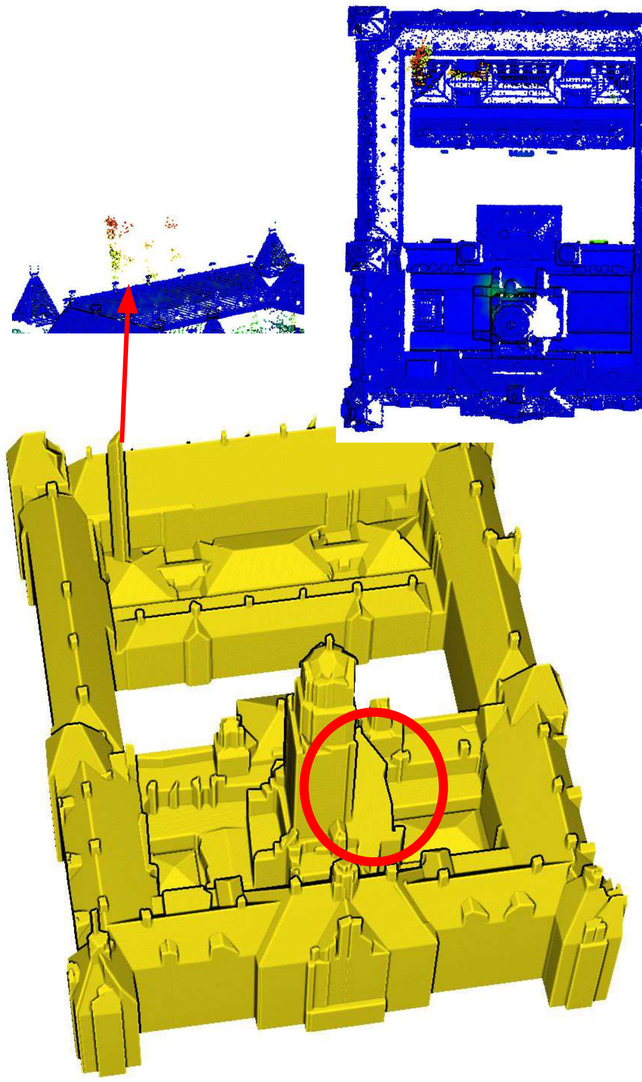
Fuse two point clouds



AHN 3



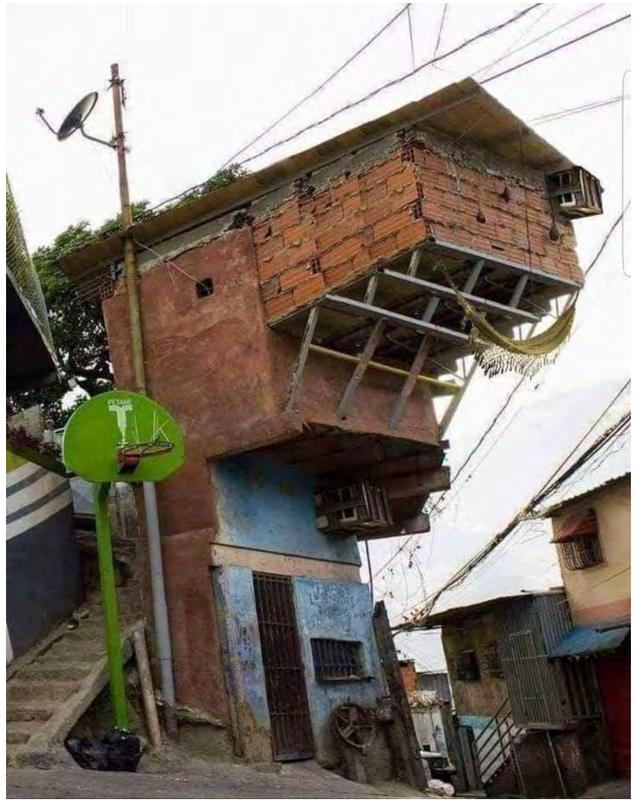
AHN 3+4



AHN 4

Image: Ravi Peters

Questions?



Module 6 contents

- Creation of 3D city models
- Processing of 3D city models + practical session
- GeoBIM integration and conversions between Geo and BIM

Processing of 3D city models contents

- Validating a 3D city model
- Operations through cjio
- Practical session

Validation of a 3D city model

Validation levels:

- syntax: is it a valid JSON or GML file?
- schema: does it conform to the CityJSON or CityGML schema?
- geometry: are the 3D primitives in the file valid?

Syntax validation (JSON)

- Types: strings, numbers, Booleans, objects, arrays and null.
- Each type has own rules, e.g. strings surrounded by double quotes.
- Plenty of tools available, e.g. JSONLint or JSON.parse() in Python.

```
{
  "first_name": "John",
  "last_name": "Smith",
  "is_alive": true,
  "age": 27,
  "address": {
    "street_address": "21 2nd Street",
    "city": "New York",
    "state": "NY",
    "postal_code": "10021-3100"
  },
  "phone_numbers": [
    {
      "type": "home",
      "number": "212 555-1234"
    },
    {
      "type": "office",
      "number": "646 555-4567"
    }
  ],
  "children": [
    "Catherine",
    "Thomas",
    "Trevor"
  ],
  "spouse": null
}
```

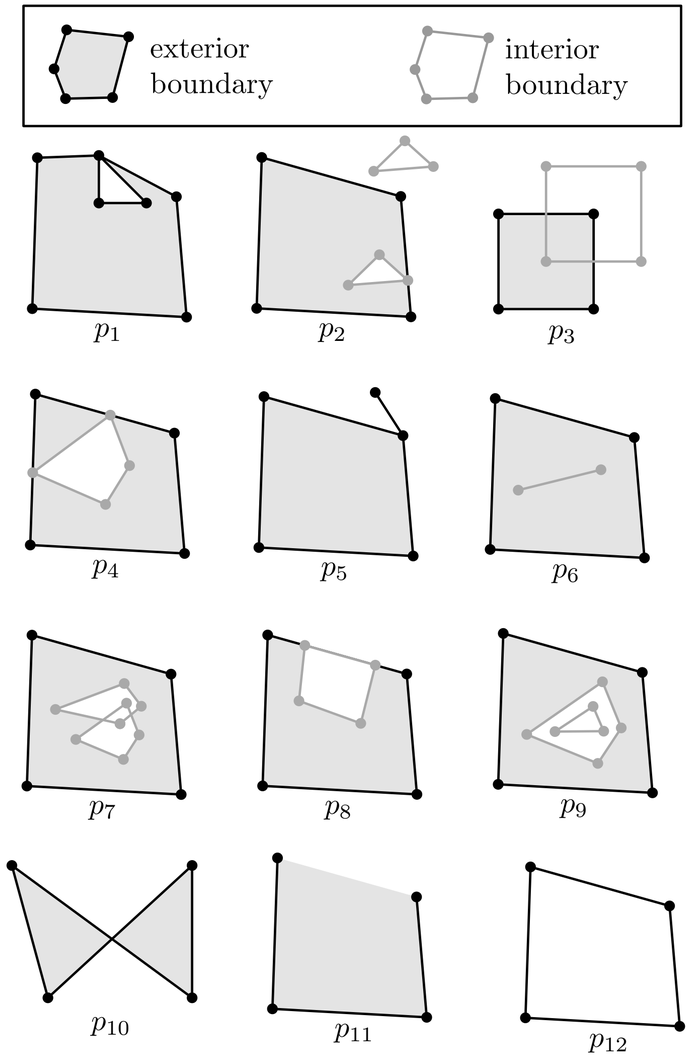
Schema validation (CityJSON)

- Checks correct structure and types using JSON Schema (https://json-schema.org/)
- Main schema for v2.0.1: https://3d.bk.tudelft.nl/schemas/cityjson/2.0.1/cityjson.schema.json
- Official validator: cjval (https://github.com/cityjson/cjval)

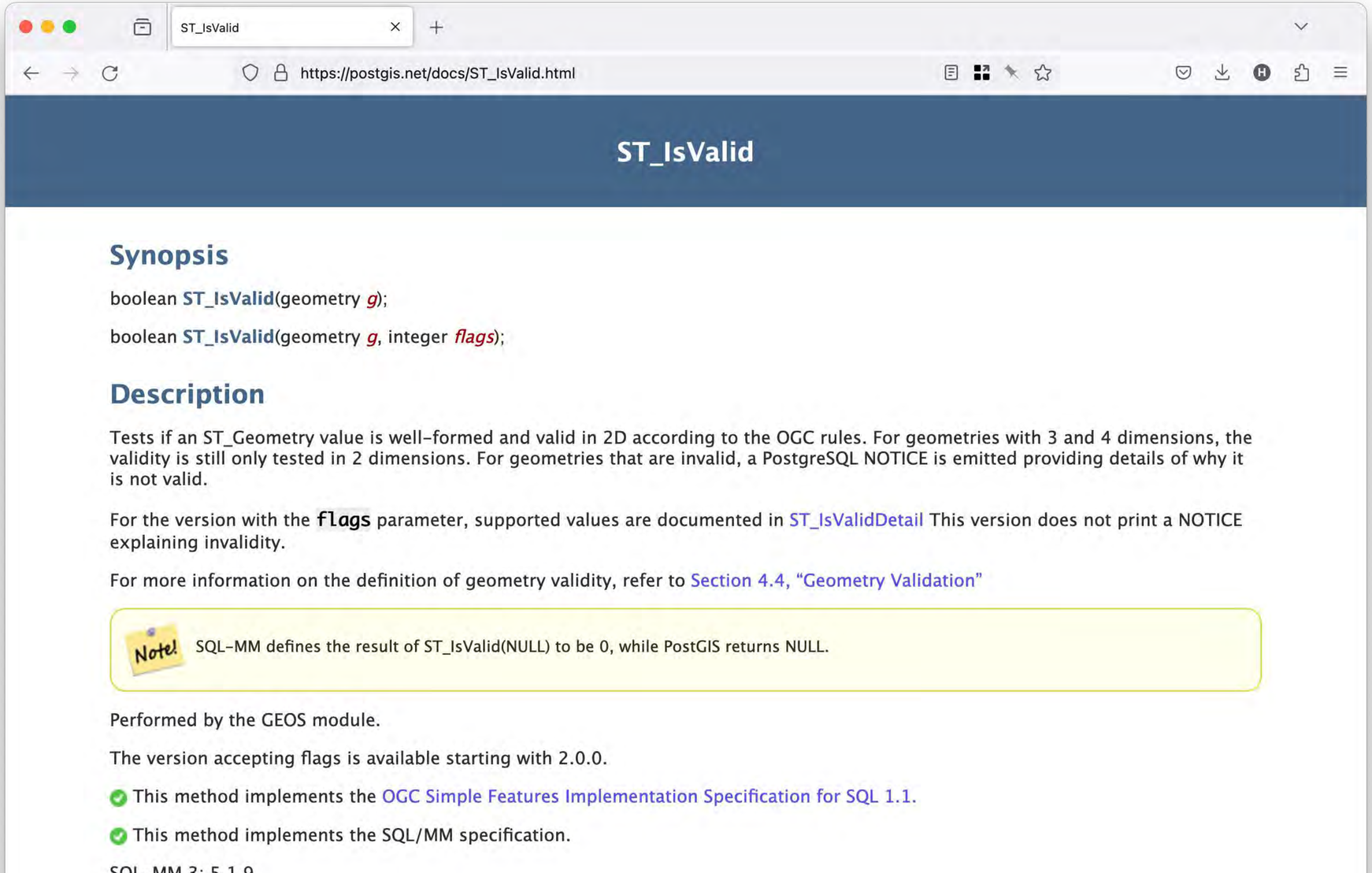
Geometry validation (2D)

OGC Simple Features and ISO19107 rules:

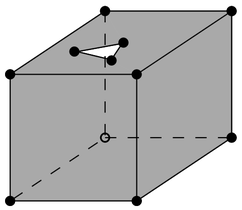
1. no self-intersection
2. closed boundaries
3. rings can touch but not overlap
4. no duplicate points
5. no dangling edges
6. connected interior
7. etc



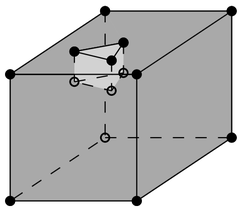
Geometry validation (2D)



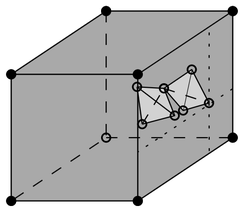
Geometry validation (3D)



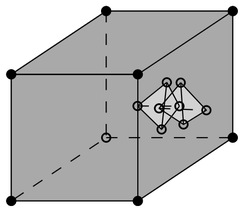
s_1
invalid (1)



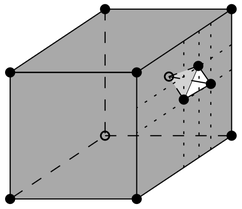
s_2
valid



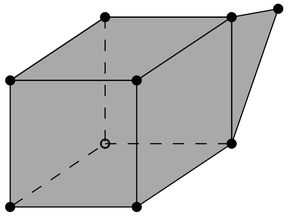
s_3
valid



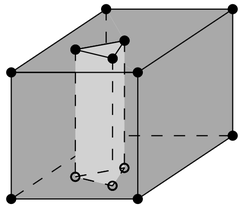
s_4
invalid (3, 6)



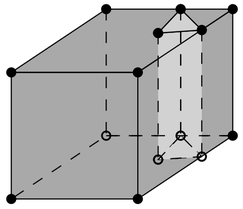
s_5
invalid (6)



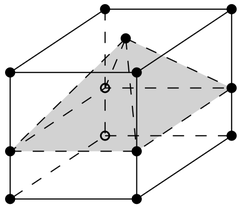
s_6
invalid (4)



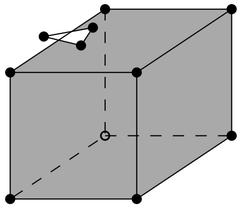
s_7
valid



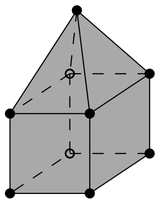
s_8
invalid (2, 5)



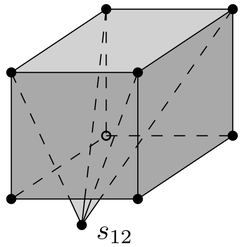
s_9
invalid (5)



s_{10}
invalid (3 in 2D)

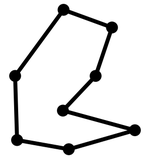


s_{11}
valid



s_{12}
invalid (2)

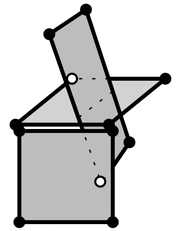
`Point`



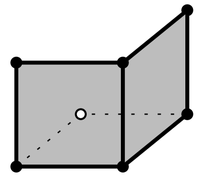
`LinearRing`



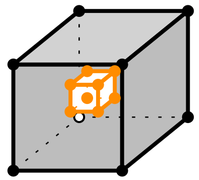
`Polygon`



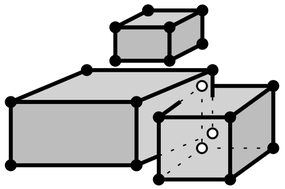
`MultiSurface`



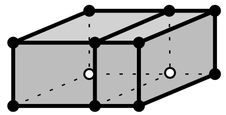
`CompositeSurface`



`Solid`

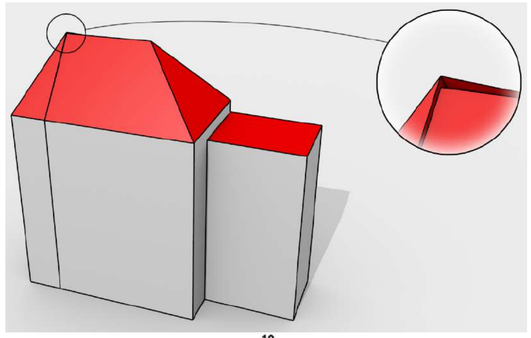


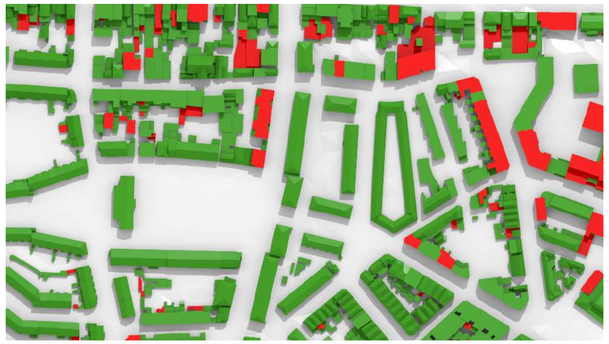
`MultiSolid`

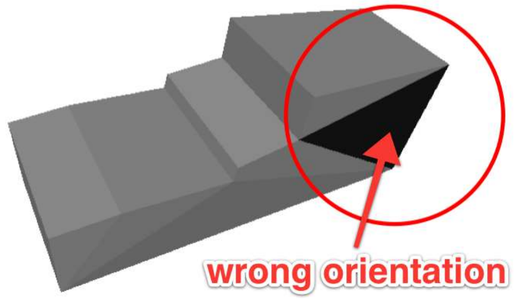


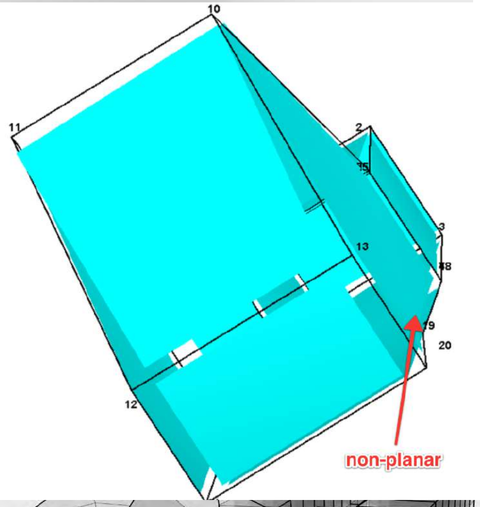
`CompositeSolid`

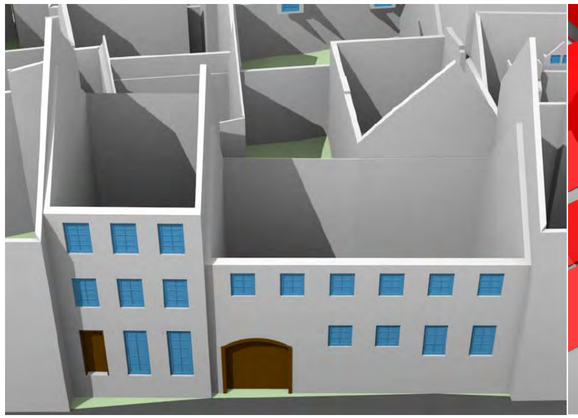
Geometry validation (3D)



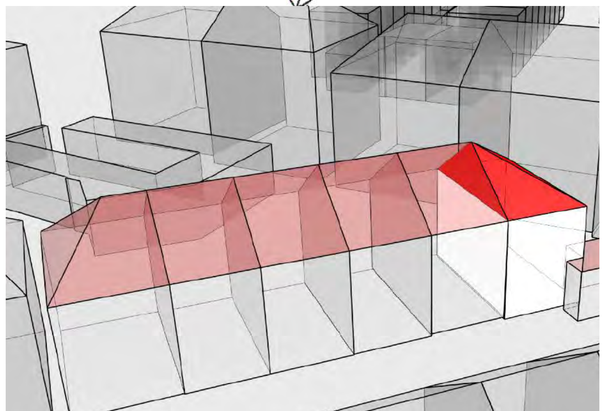


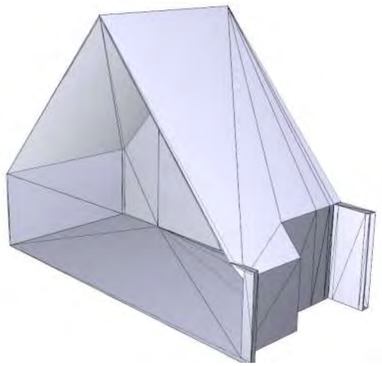


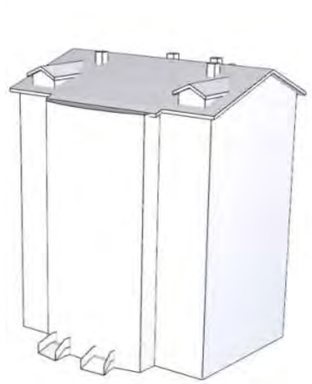


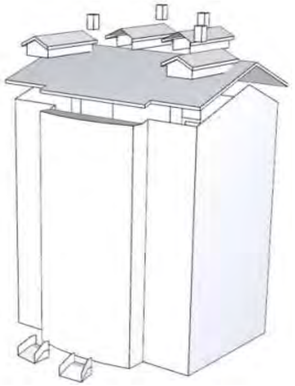




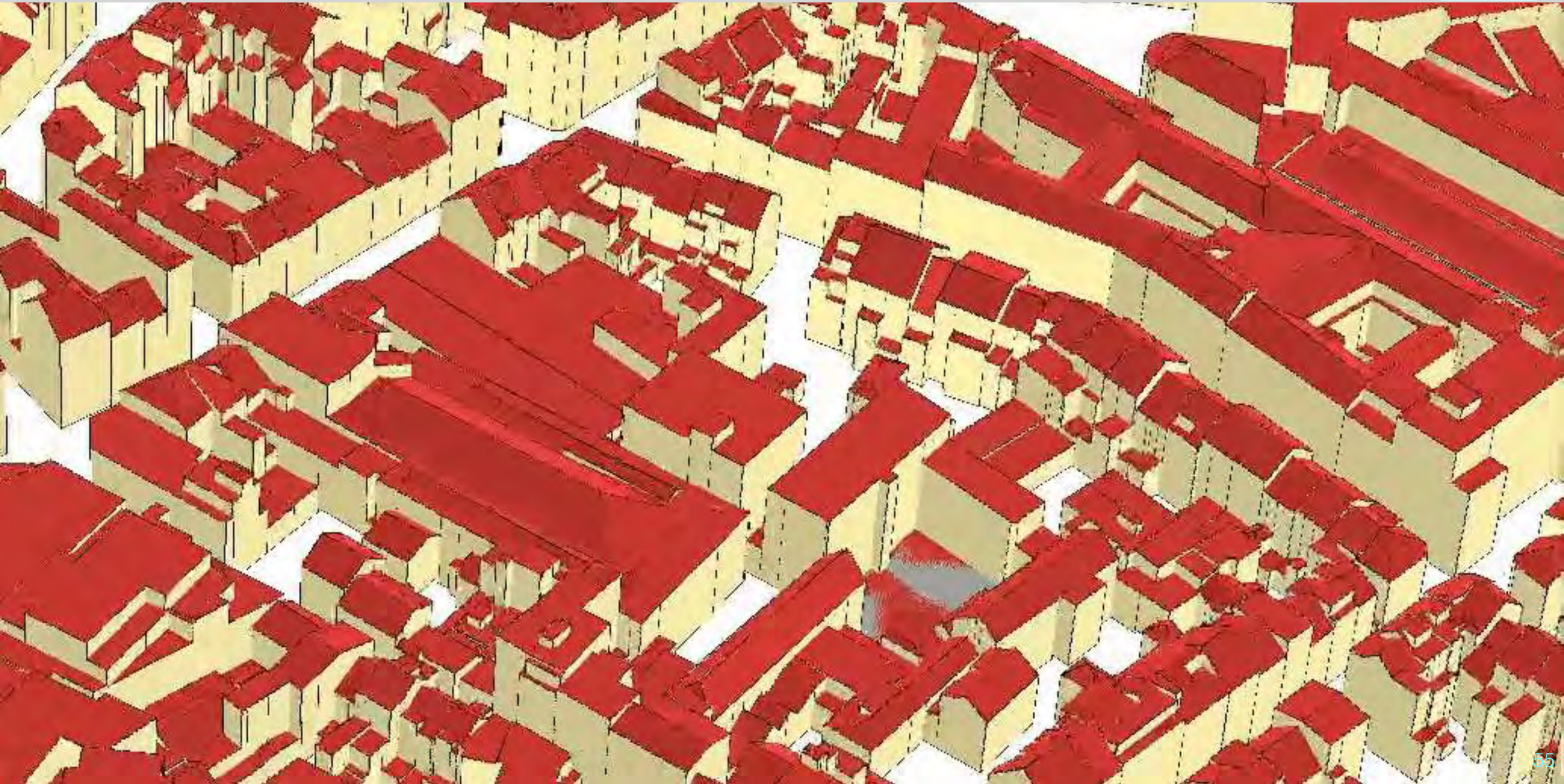




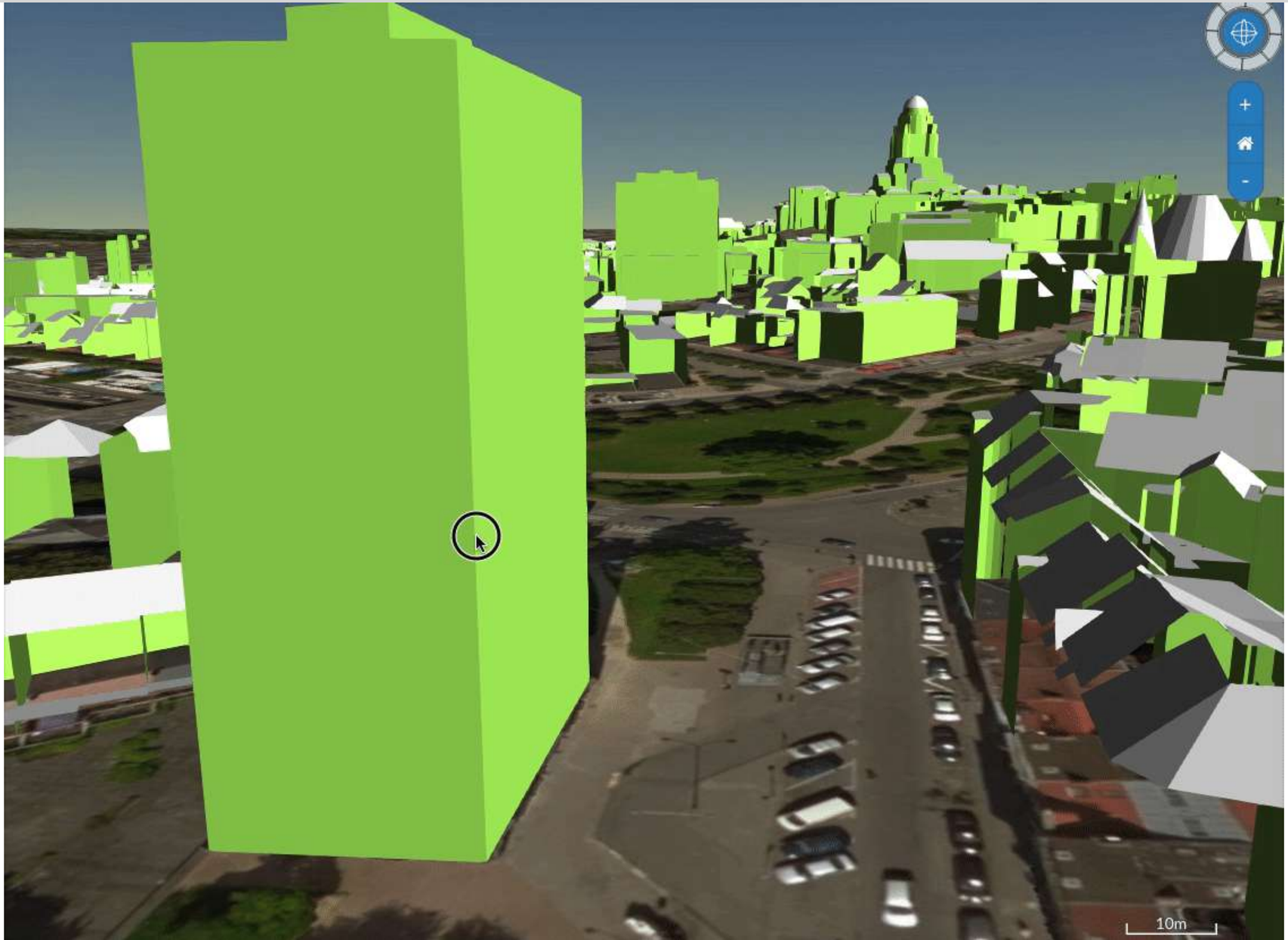




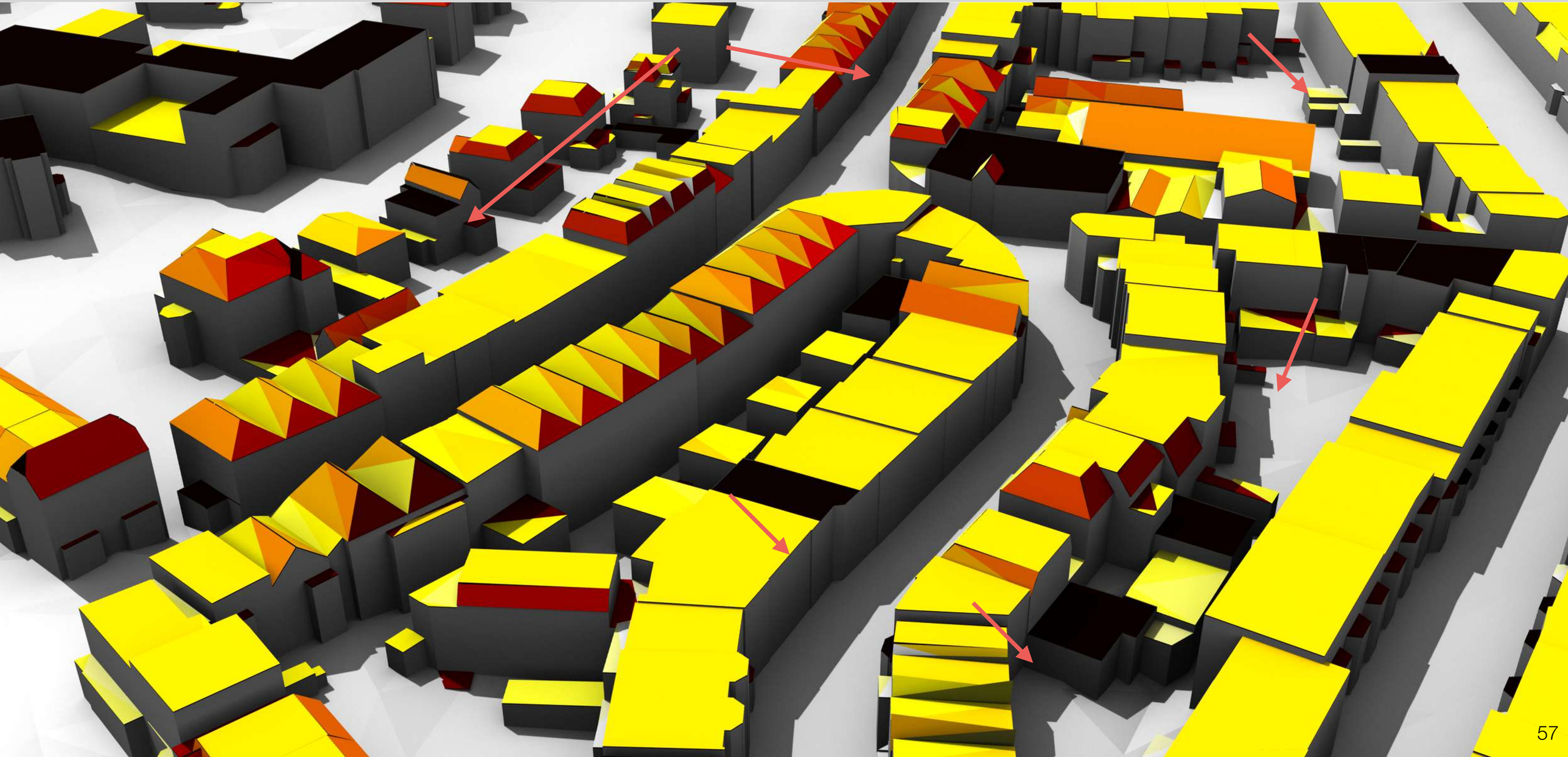
Geometry validation (3D)



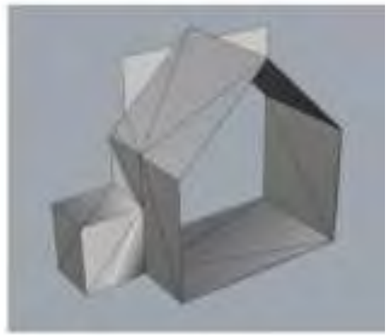
Geometry validation (3D)



Geometry validation (3D)

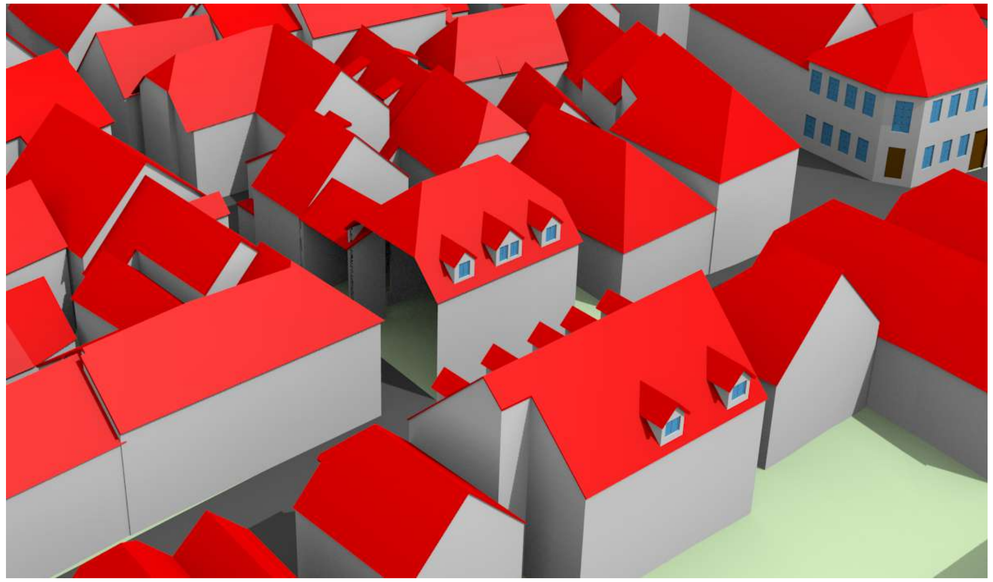


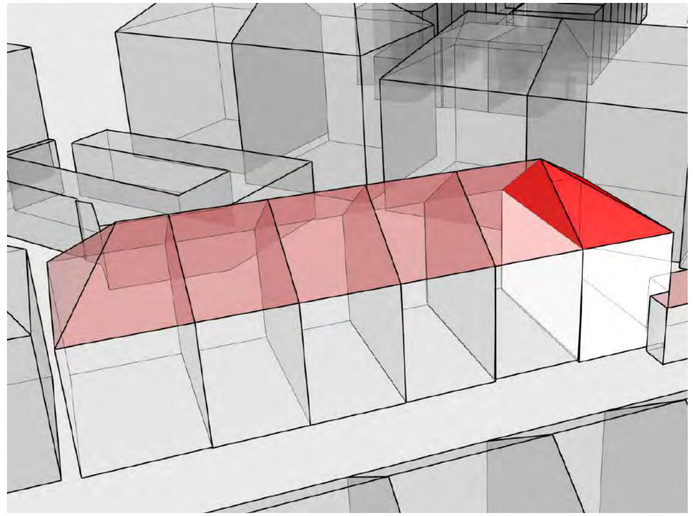
Geometry validation (3D)





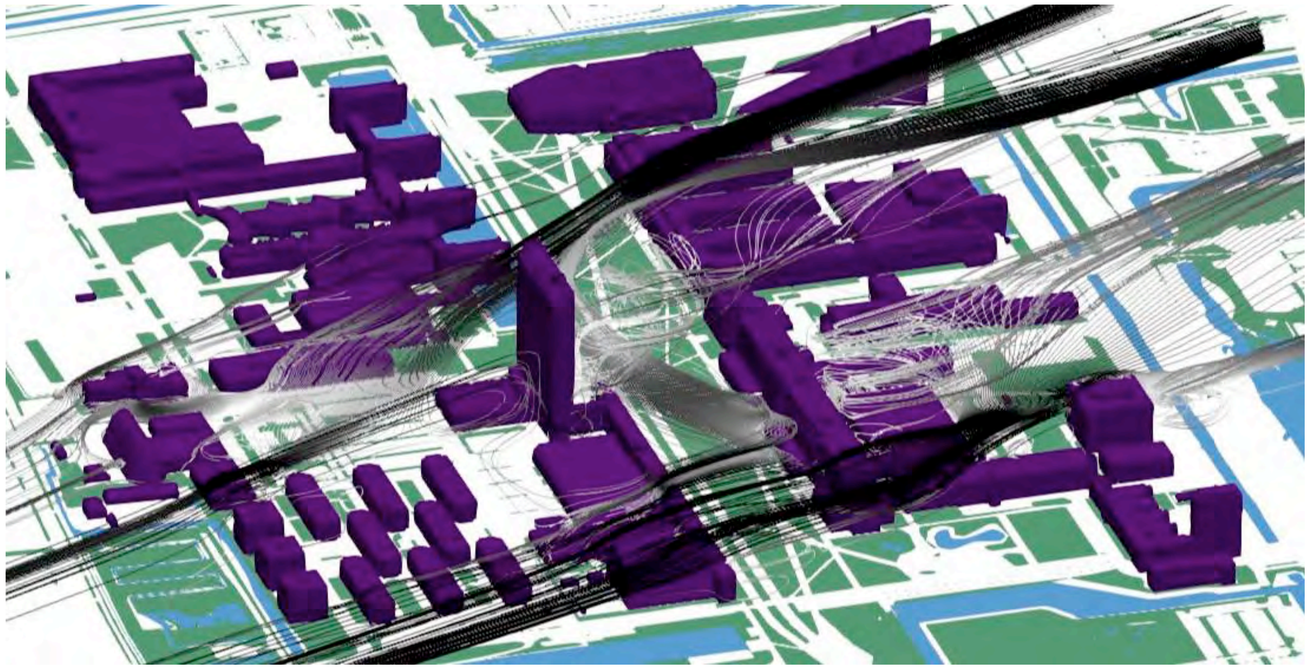






Geometry validation (3D)

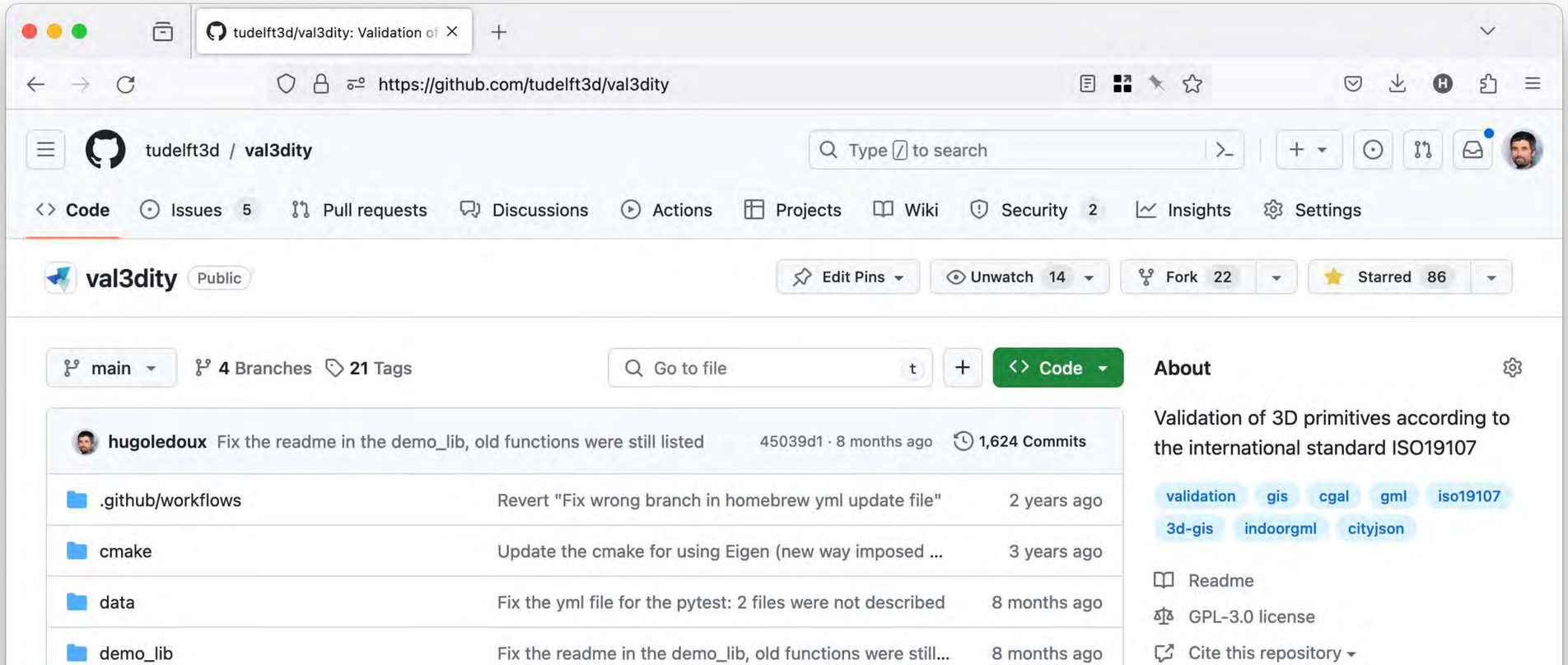
- Advanced simulations: very strict validity requirements
- In practice, up to 90% of time is spent fixing large models



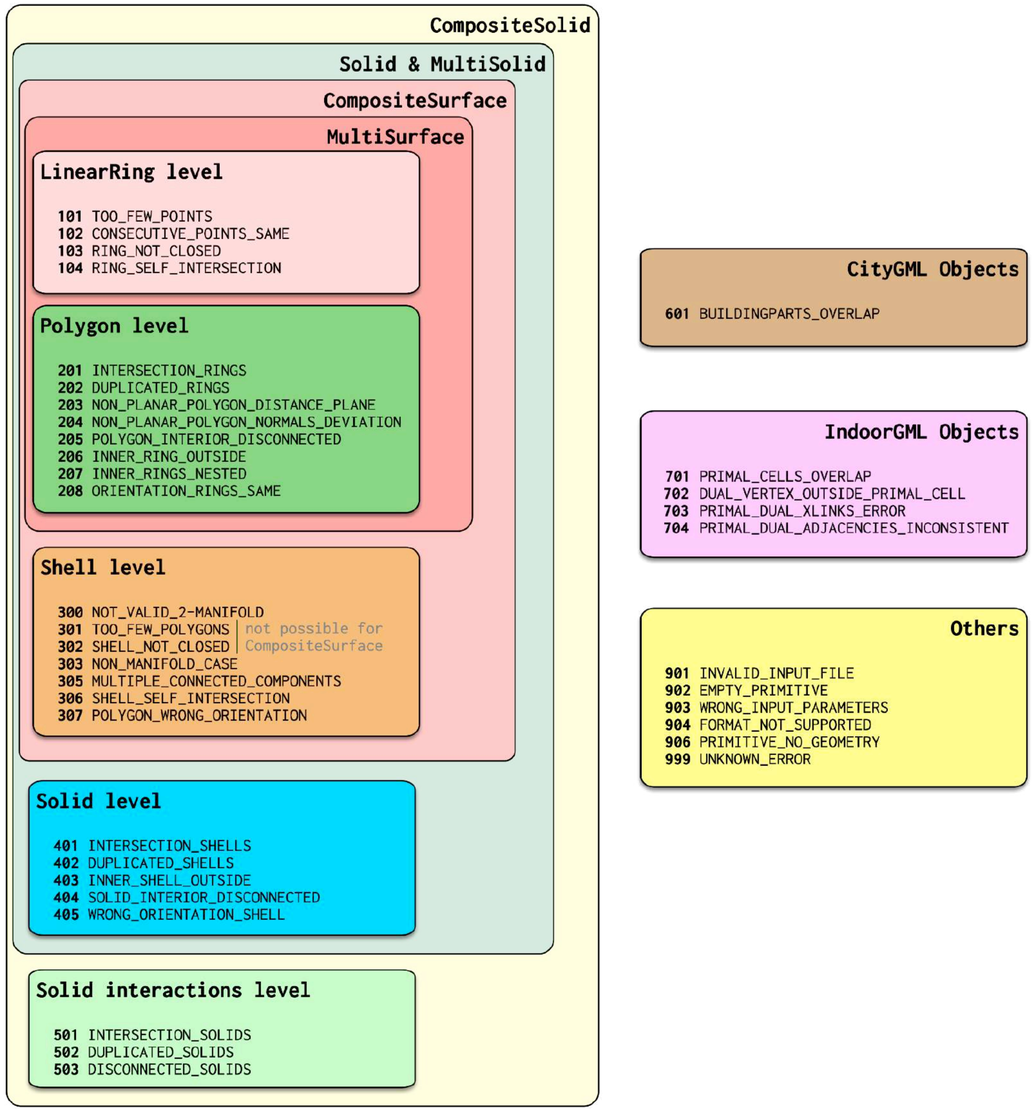
Geometry validation (3D)

https://github.com/tudelft3d/val3dity (download) or

http://geovalidation.bk.tudelft.nl/val3dity/ (online for small models)



Geometry validation (3D)



CityGML Objects

601 BUILDINGPARTS_OVERLAP

IndoorGML Objects

701 PRIMAL_CELLS_OVERLAP
702 DUAL_VERTEX_OUTSIDE_PRIMAL_CELL
703 PRIMAL_DUAL_XLINKS_ERROR
704 PRIMAL_DUAL_ADJACENCIES_INCONSISTENT

Others

901 INVALID_INPUT_FILE
902 EMPTY_PRIMITIVE
903 WRONG_INPUT_PARAMETERS
904 FORMAT_NOT_SUPPORTED
906 PRIMITIVE_NO_GEOMETRY
999 UNKNOWN_ERROR

..teaching/2024/iso19107

```
~/stacktmp/teaching/2024/iso19107 (0.041s)
val3dity cube_flipped.obj --report r.json
Validation of 1 feature(s):
[==================================================] 100%

+++++++++++++++++++ SUMMARY +++++++++++++++++++
INVALID :(
+++++
Input file type:
  OBJ
+++++
Total # of Features:          1
  # valid:                    0 (0.0%)
  # invalid:                  1 (100.0%)
Types:
  GenericObject
+++++
Total # of primitives:        1
  # valid:                    0 (0.0%)
  # invalid:                  1 (100.0%)
Types:
  Solid
+++++
Errors present:
  303 -- NON_MANIFOLD_CASE
         1 primitive(s)
  307 -- POLYGON_WRONG_ORIENTATION
         1 primitive(s)
++++++++++++++++++++++++++++++++++++++++++++++++

Validation report saved to "/Users/hugo/stacktmp/teaching/2024/iso19107/r.json"
Browse its content:
==>http://geovalidation.bk.tudelft.nl/val3dity/browser/

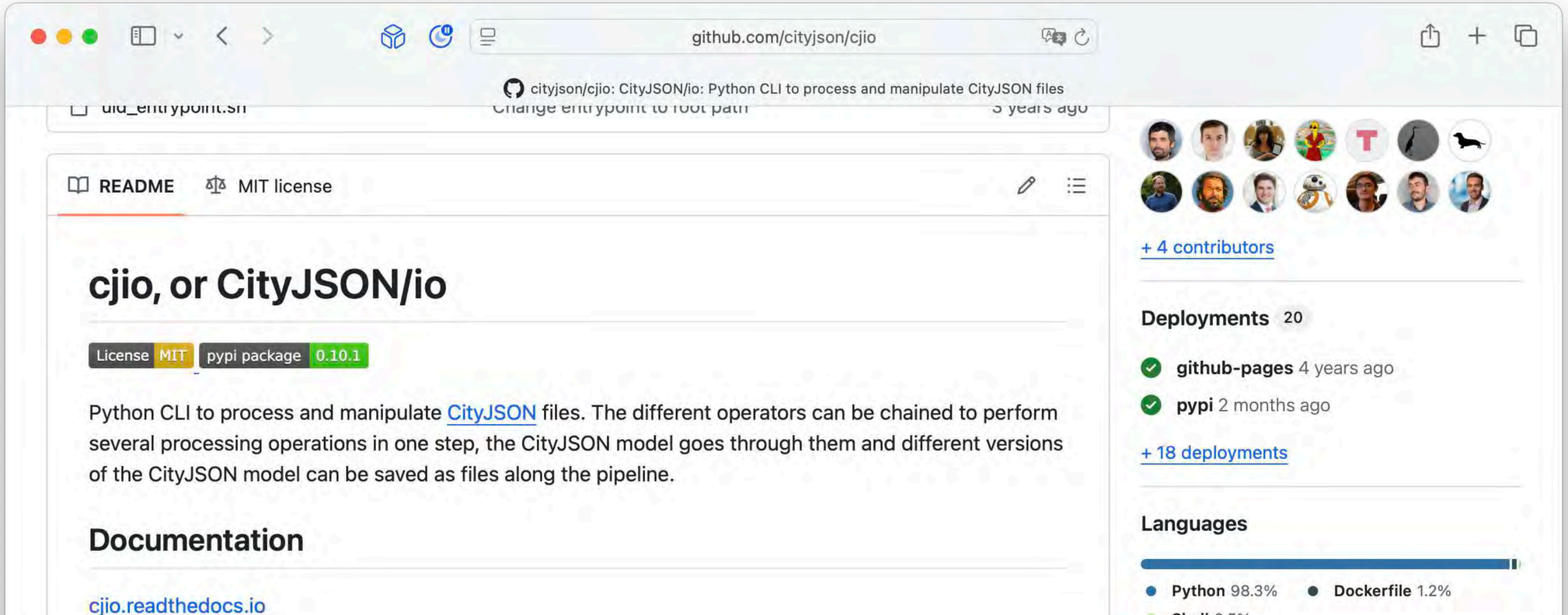
~/stacktmp/teaching/2024/iso19107
```

e303

e307

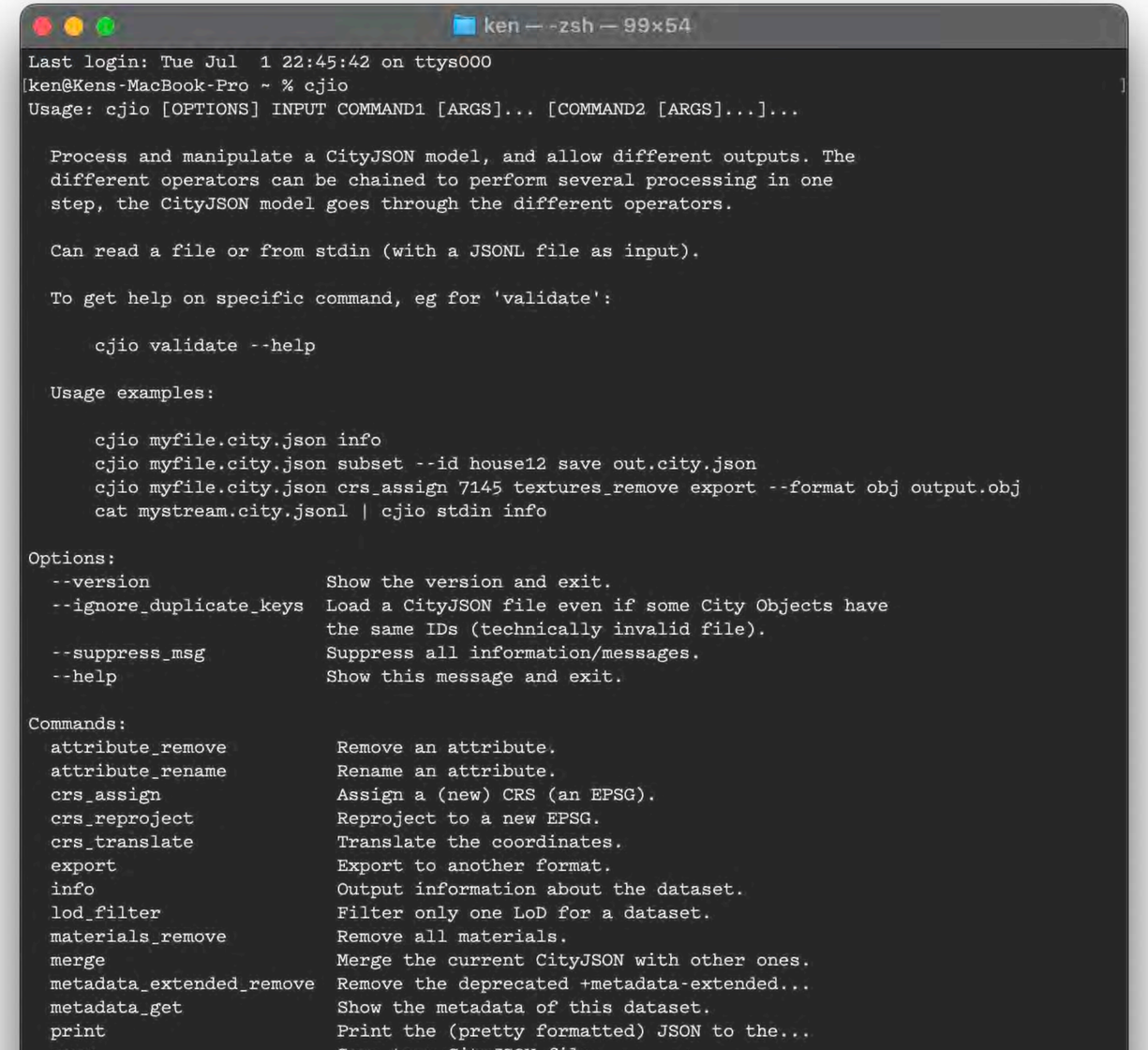
Operations through cjio

- cjio or CityJSON/io
- https://cjio.readthedocs.io/en/latest/

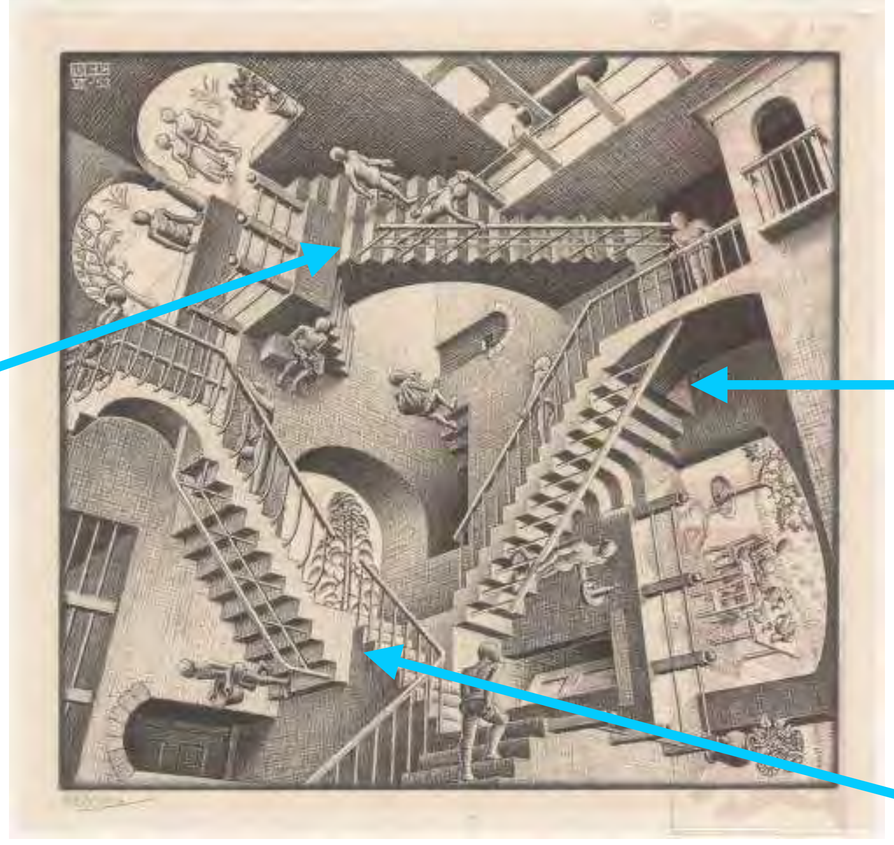


Operations through cjio

- attribute removal or renaming
- CRS assignment, reprojection or translation
- export CityJSONSeq, OBJ, glTF, b3dm or STL
- subset using id, bounding box, type, radius around point, etc.
- triangulate faces
- schema validation (using cjval)



Questions?



Not valid

Not valid

Not valid

Module 6 contents

- Creation of 3D city models
- Processing of 3D city models + practical session
- GeoBIM integration and conversions between Geo and BIM

Practical session 4

- Create your own 3D city model using 3dfier: http://tudelft3d.github.io/3dfier/
- Find two datasets for a region of your interest:
  - A set of non-overlapping polygons that include building footprints (plus potentially other types)
  - A point cloud with elevation data, either Lidar or photogrammetric
- See: http://tudelft3d.github.io/3dfier/generate_lod1.html

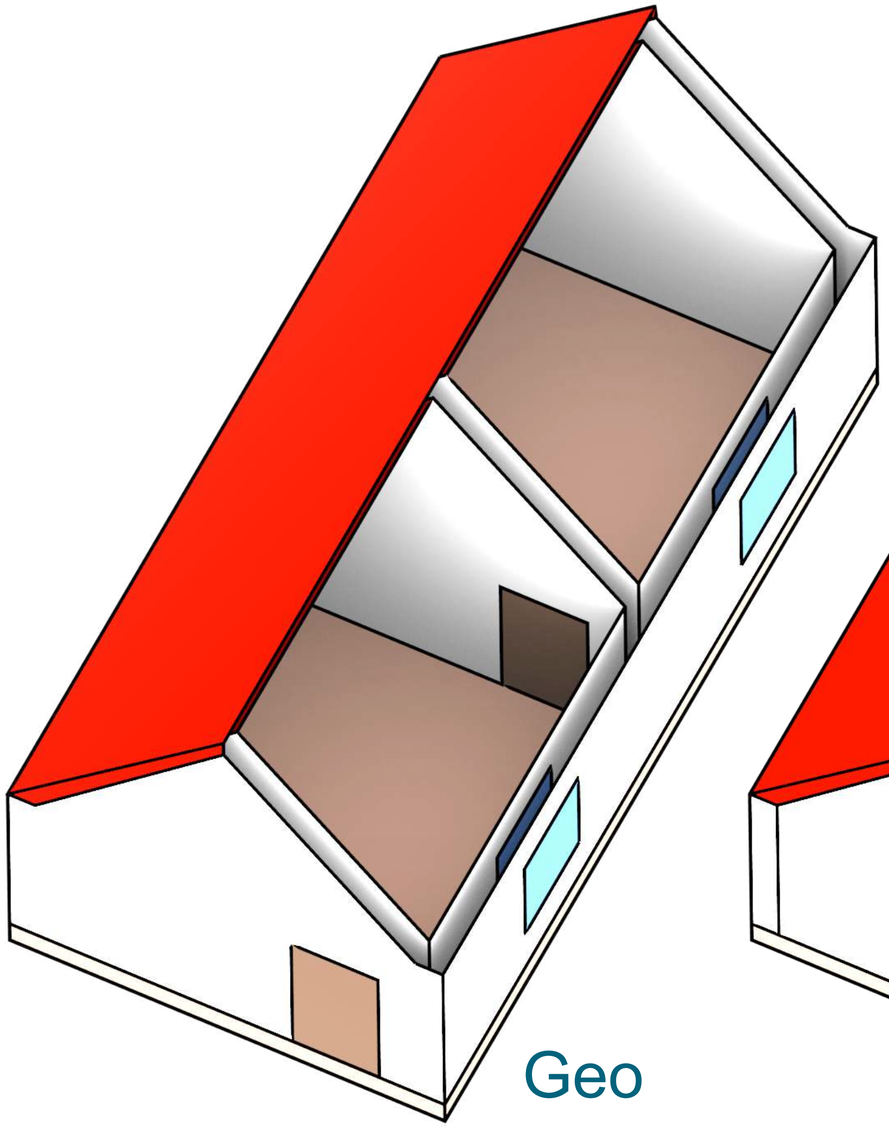
GeoBIM integration contents

- Comparison of Geo and BIM
- GeoBIM integration: 3 approaches

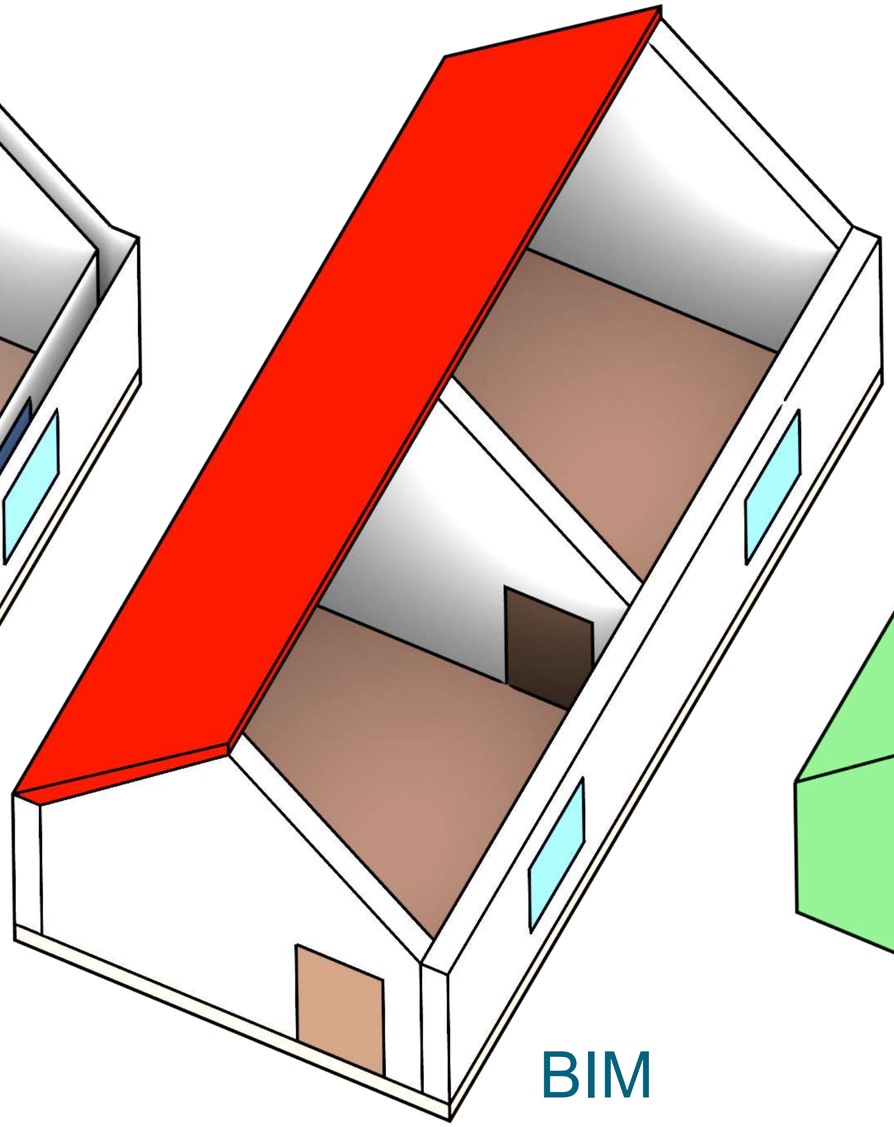
Differences between Geo and BIM

	Geo (3D city models)	BIM
origins	cartography, maps	architecture, CAD
scale	large regions	one construction site
made using	processed sensed data	usually manual as a design
detail (geom/semantics)	less detailed	very detailed
models	visible semantic surfaces	volumetric built elements
up to date	based on input data	as designed, maybe as built
focus	everything but mainly cities	buildings and infrastructure
strengths	spatial analyses	design and construction

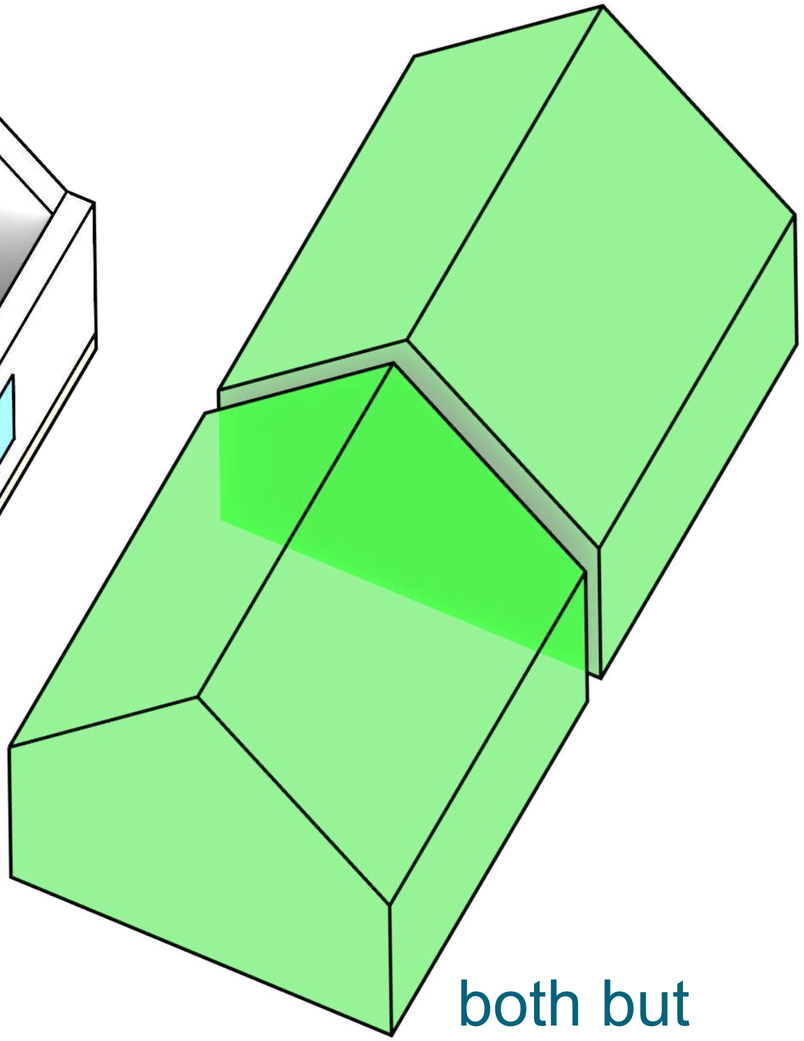
Differences between Geo and BIM



Geo



BIM



both but
with issues

GeoBIM integration

- Geo and BIM are mutually complementary, which leads us to…
- GeoBIM: joint usage of GIS (Geo) and BIM data, usually through:
  - Geo to BIM conversion (for use in BIM software)
  - BIM to Geo conversion (for use in Geo software)
  - Conversion / mapping to another model (e.g. joint model using OWL/ RDF/SPARQL or an application-specific model)

Why GeoBIM integration?

For Geo:

- High LoD cadastre including small features e.g. balconies
- Avoid (some) data acquisition
- Information about building interiors
- Continuous data updates
- Data exchange with other fields, e.g. AEC or asset management

Why GeoBIM integration?

For BIM:

- Reference context for design
- Conduct checks that require surroundings, e.g. daylight simulations
- Multi-scale vision for applications, e.g. asset management
- Data exchange with other fields, e.g. planners and environmental engineers
- Techniques for scan to BIM come from Geo side

Why GeoBIM integration?

Shared benefits:

- Data interoperability
- Cost and time savings
- Digital twin development
- Sustainability and resource planning

Integration vs. Interoperability

- **Interoperability** is the ability of systems or products to operate effectively and efficiently in conjunction, on the exchange and reuse of available resources, services, procedures, and information, in order to fulfil the requirements of a specific task (Kavouras and Kokla, 2007).

- **Integration** is the combination or conflation of information from different data sets (Worboys, Duckham, 2004).

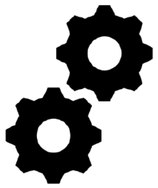
Integration vs. Interoperability

Data **Interoperability** (of a single dataset)
=
Data format
+
Info enabling data exchange and reuse (metadata)
+
Alignment with use case requirements
+
Alignment with software/application requirements

Including

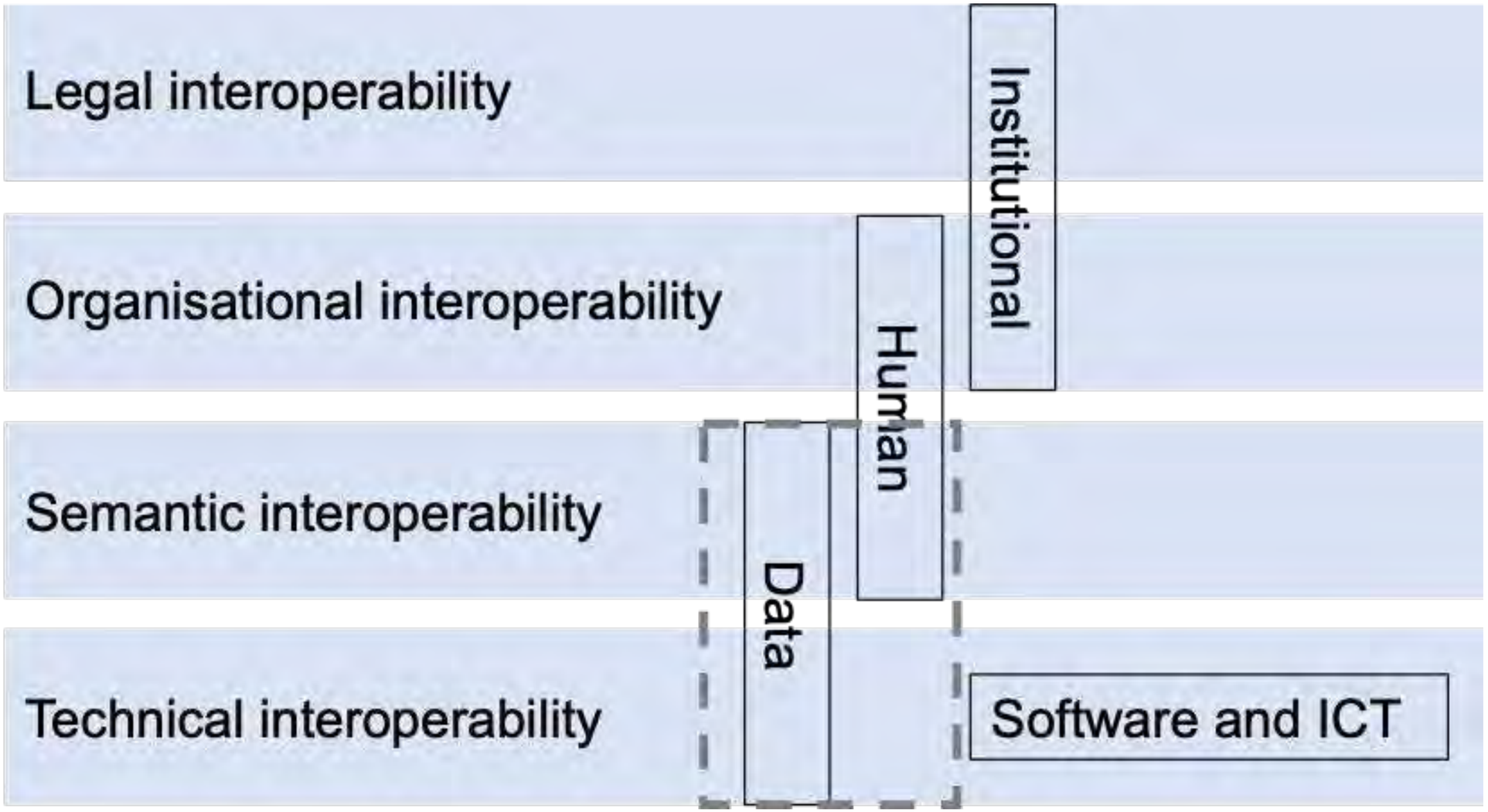
Data **Integration** (of two or more datasets)
=
Data harmonization
+
Data Merge/fusion/combine

Guided by





Integration vs. Interoperability



Integration vs. Interoperability

-

Open data models

Open protocols definitions and software components

Best practices and users agreements

CityGML CityJSON

LandInfra/InfraGML

IndoorGML

INSPIRE: Infrastructure for Spatial Information in Europe

gbXML

buildingSMART International

Home Standards Services Resources

Data standards	Workflow standards	Interface standards (APIs)
Industry Foundation Classes (IFC)	Information Delivery Specification (IDS)	Shared/Common API (Foundations API)
› IFC Specifications database	BIM Collaboration Format (BCF)	BCF API
› IFC Formats	› bcfXML	Documents API
› Model View Definitions (MVD)	Information Delivery Manual (IDM)	Property Exchange API (coming soon)
› MVD Database	› IDM Database	

OGC APIs | Building Blocks for Location

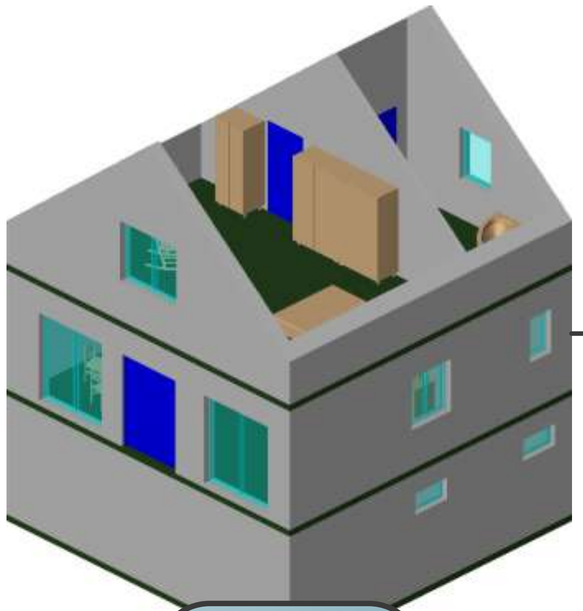
GeoBIM integration contents

- Comparison of Geo and BIM
- GeoBIM integration: 3 approaches



Image: GIM International, 2021

BIM to Geo conversion

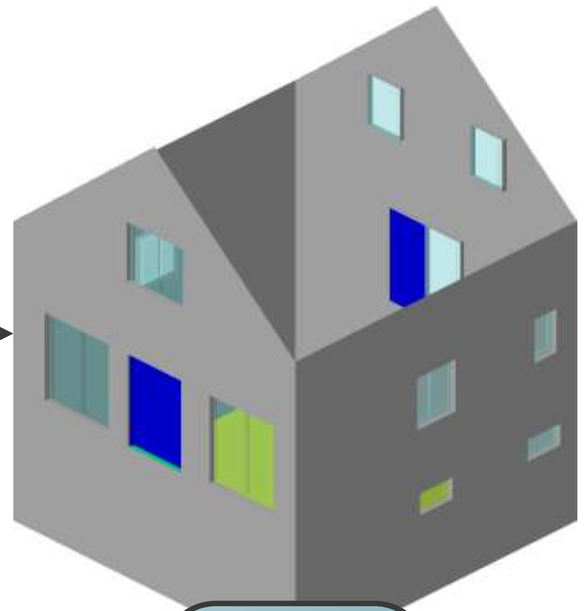


IFC

Semantic Mapping

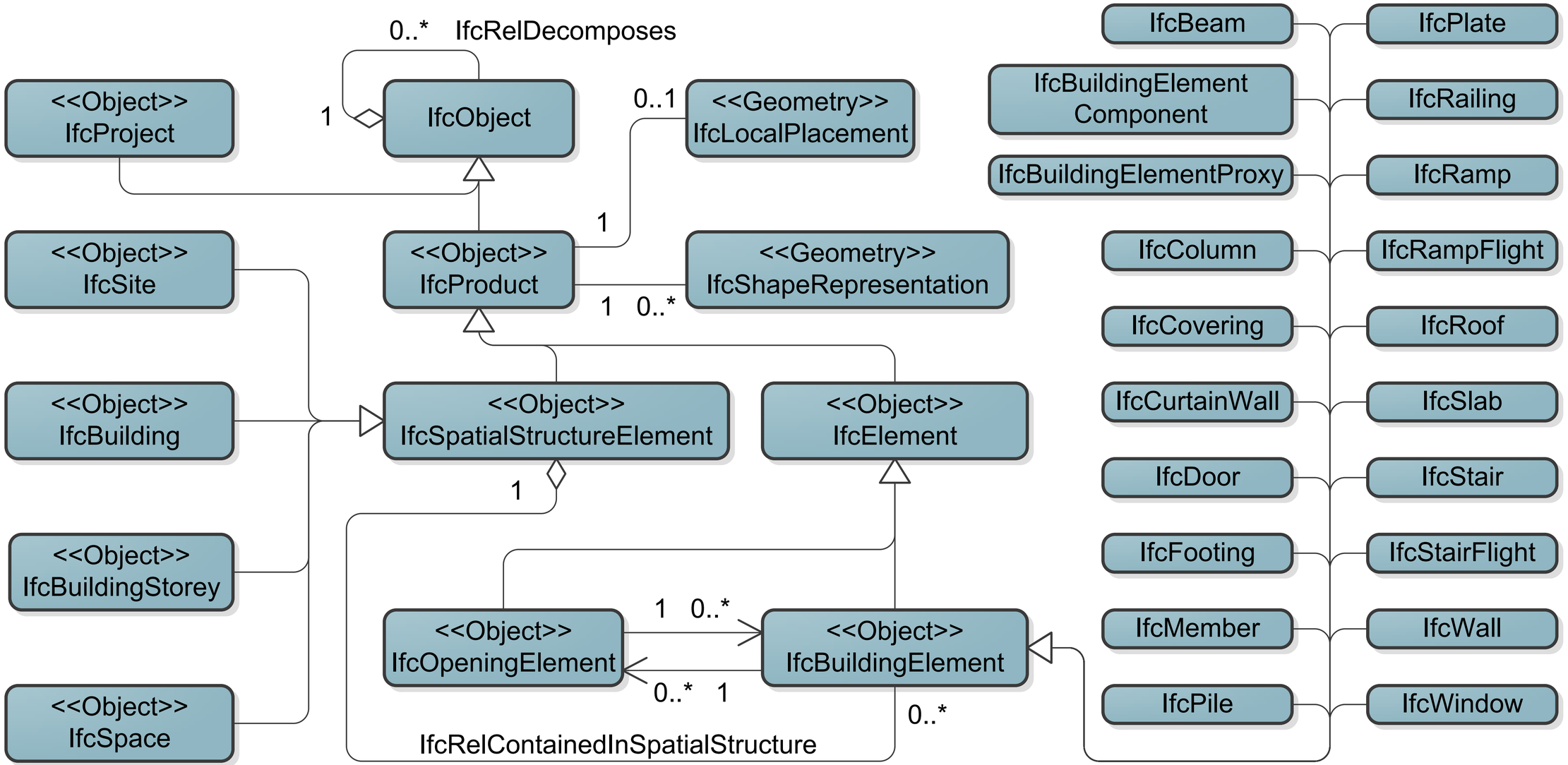
Geometric Transformation

Geometric & Semantic Refinement

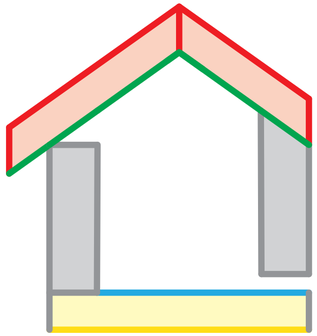


CityGML

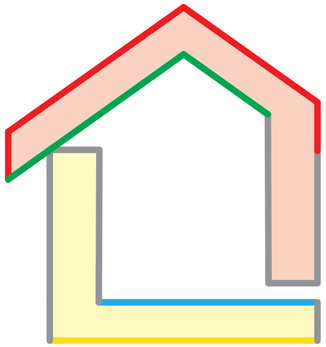
BIM to Geo conversion



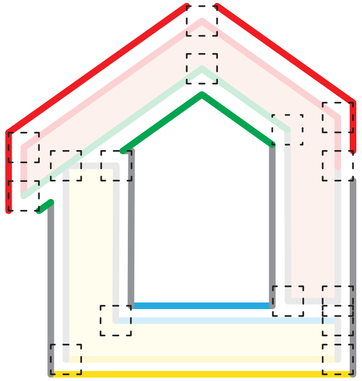
BIM to Geo conversion



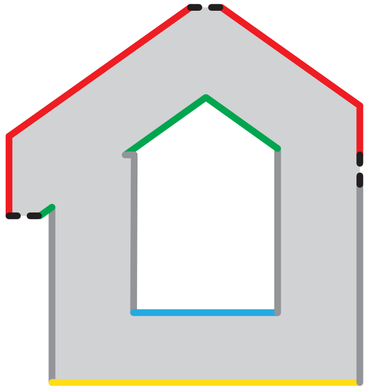
(a) input



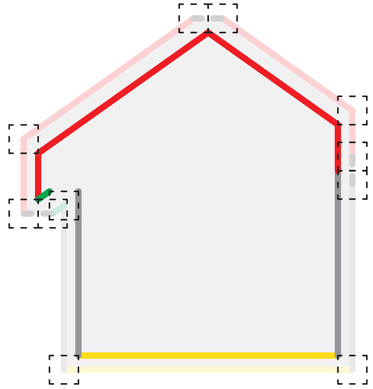
(b) union



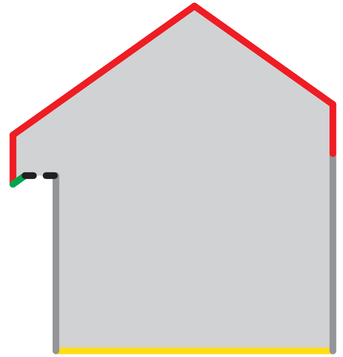
(c) dilation



(d) result

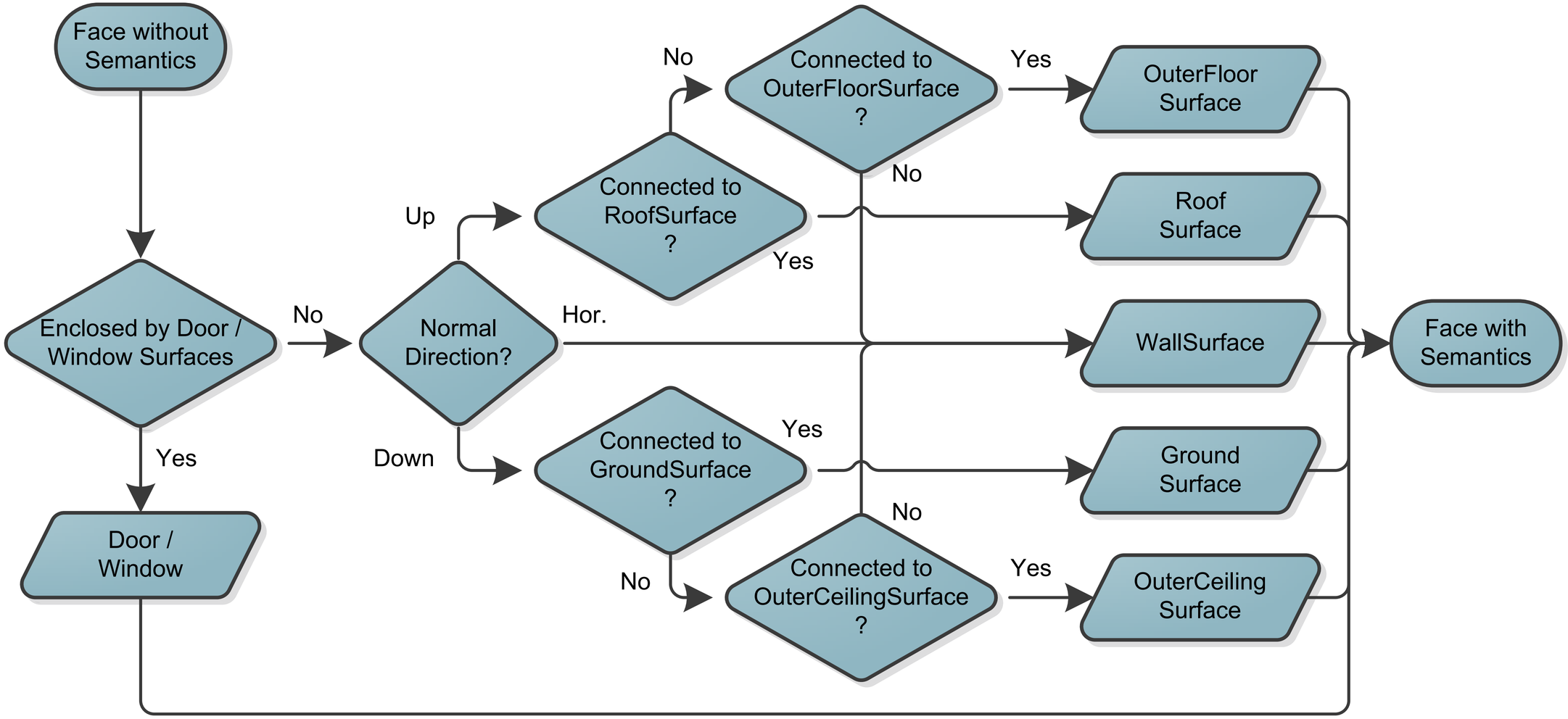


(e) erosion

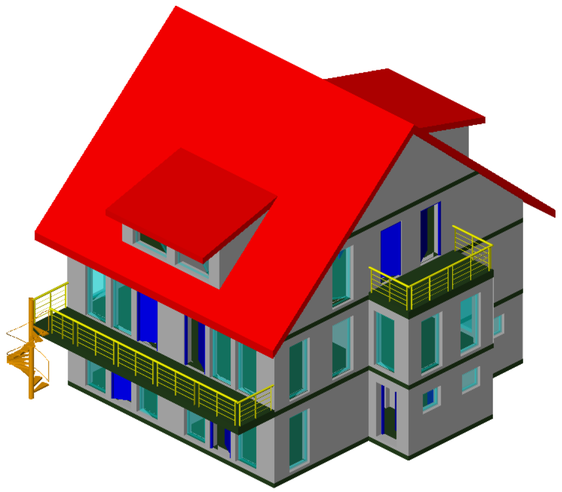


(f) final result

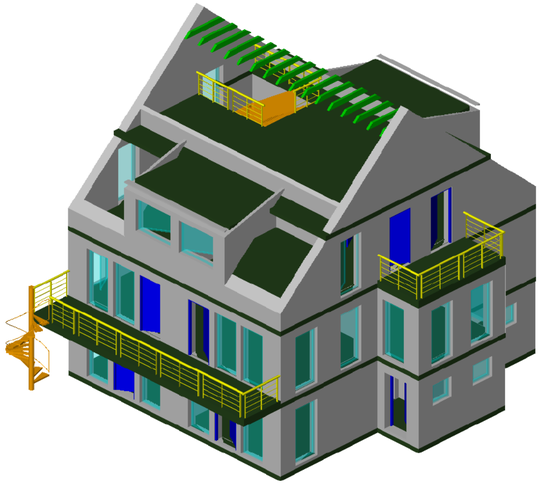
BIM to Geo conversion



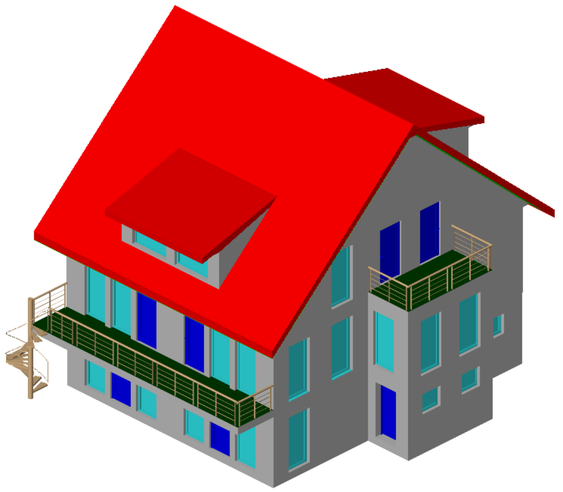
BIM to Geo conversion



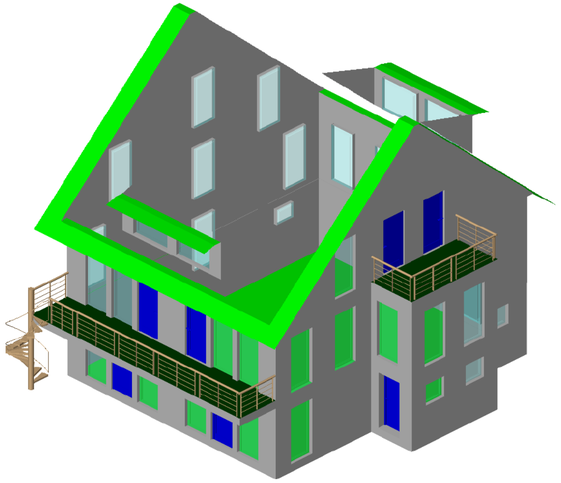
(a) input IFC



(b) IFC without roof

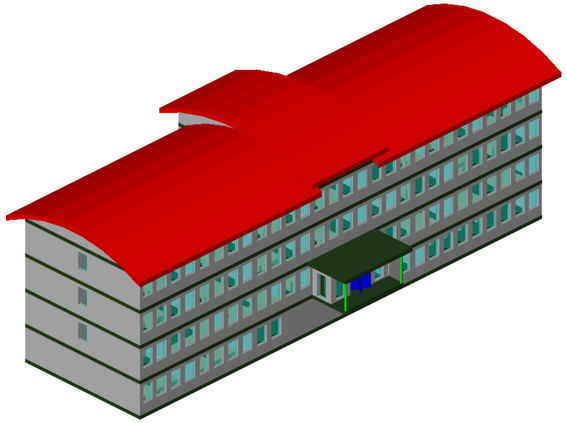


(c) output CityGML

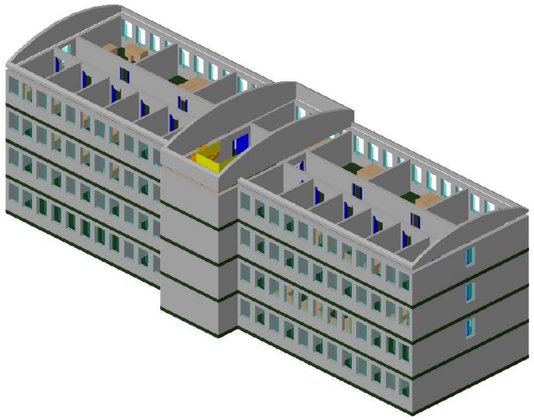


(d) CityGML without roof

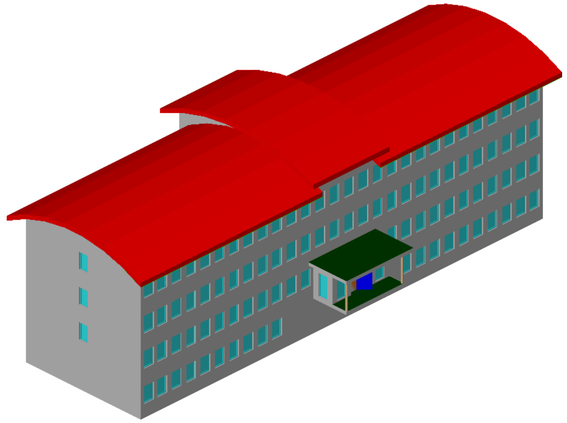
BIM to Geo conversion



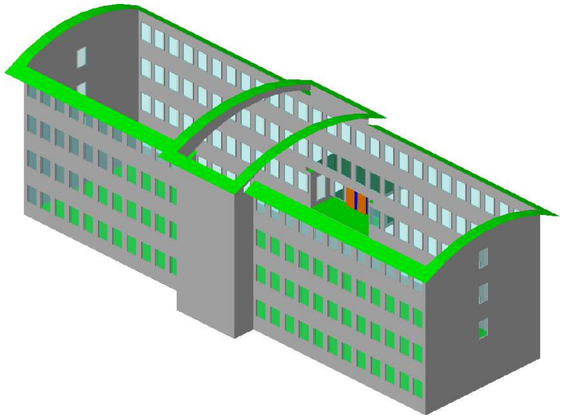
(a) input IFC



(b) IFC without roof

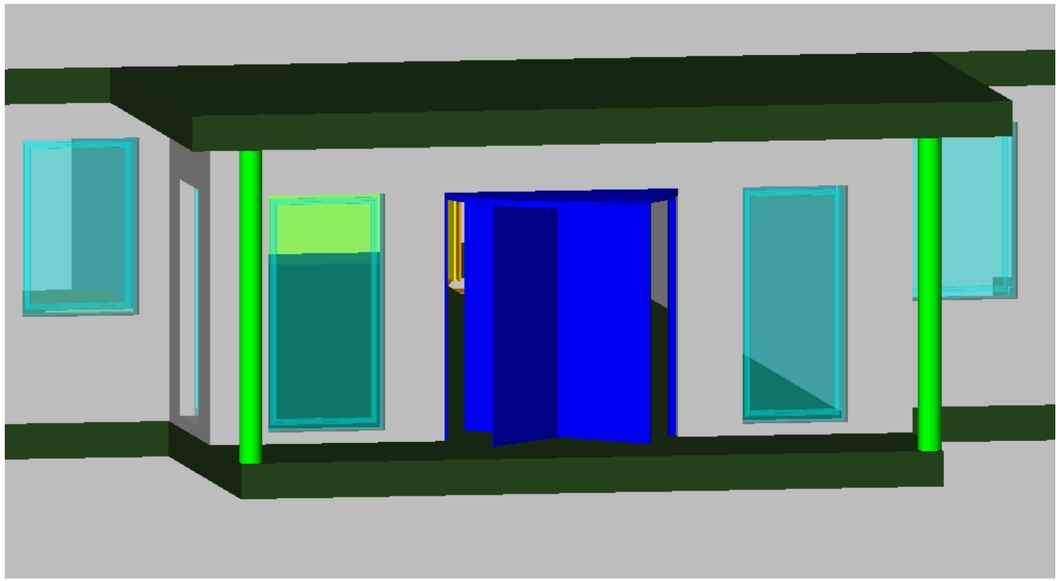


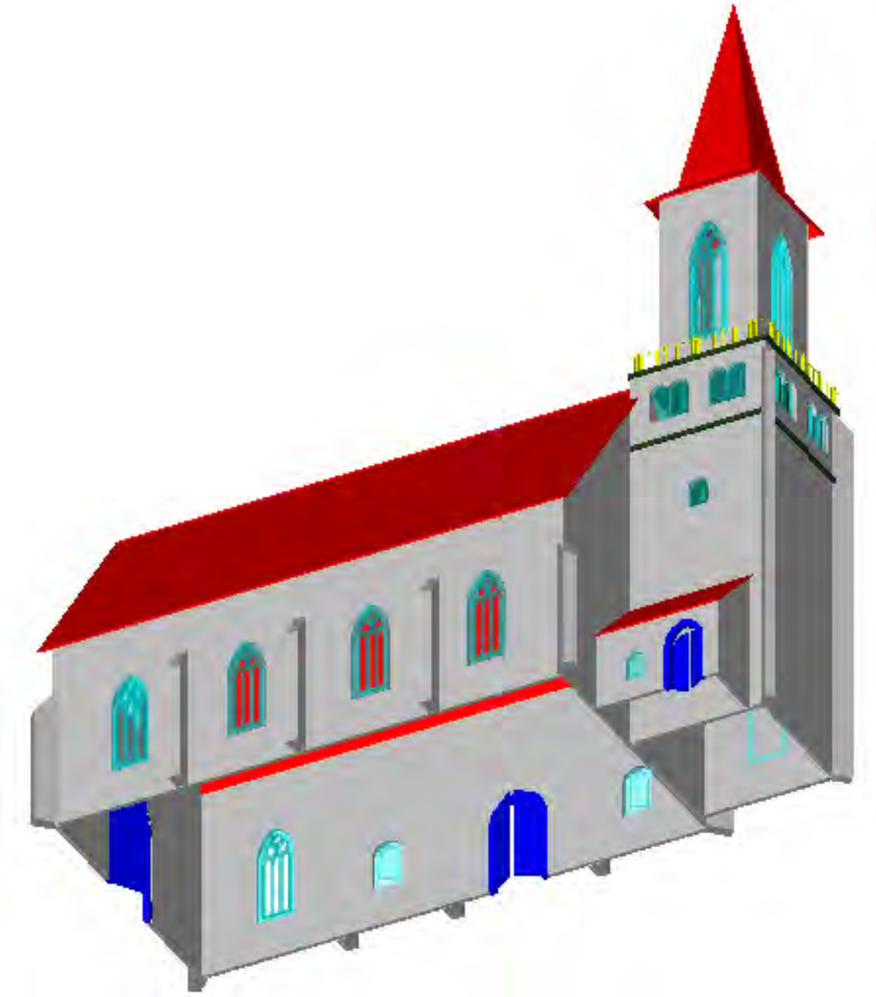
(c) output CityGML



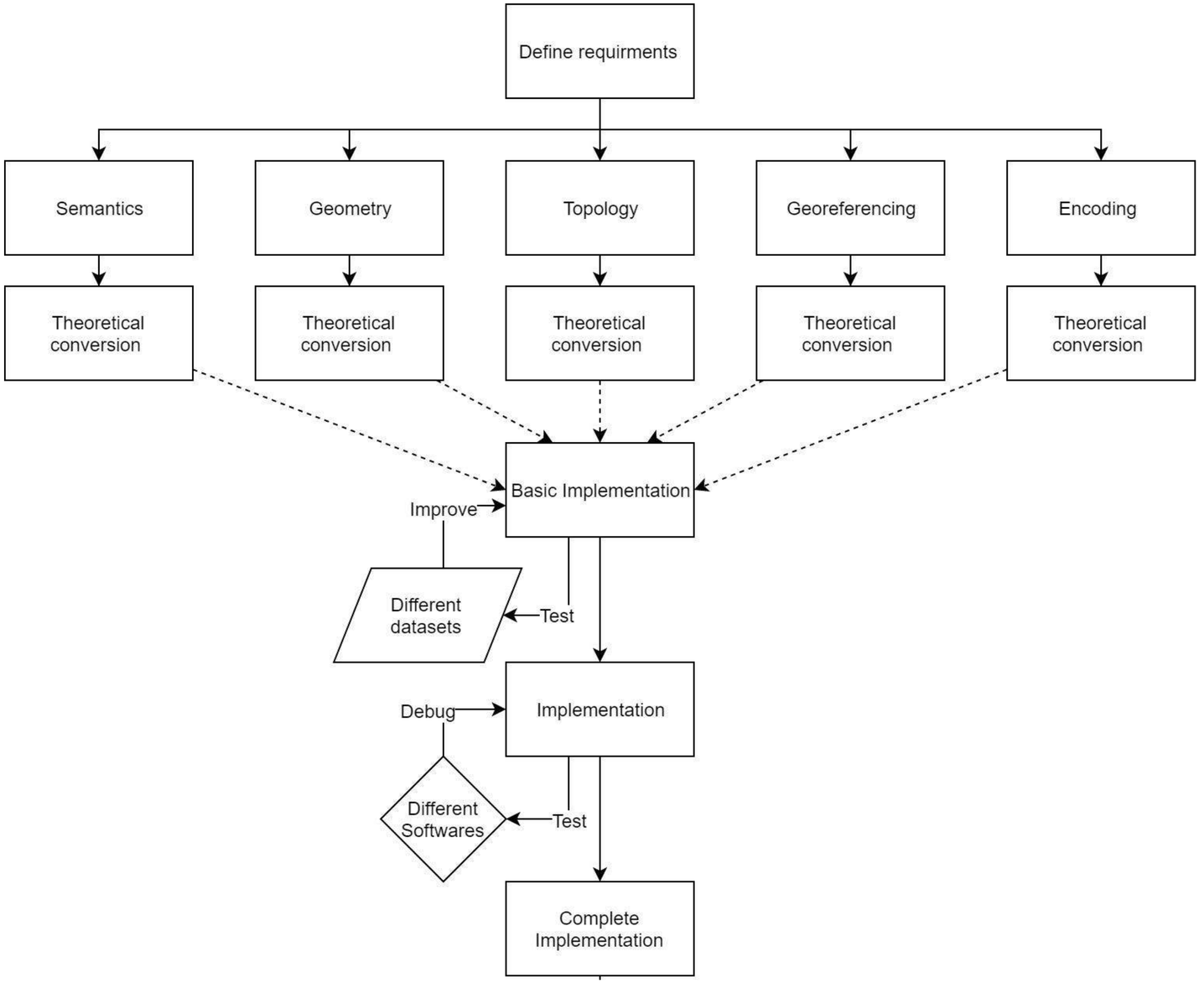
(d) CityGML without roof

BIM to Geo conversion

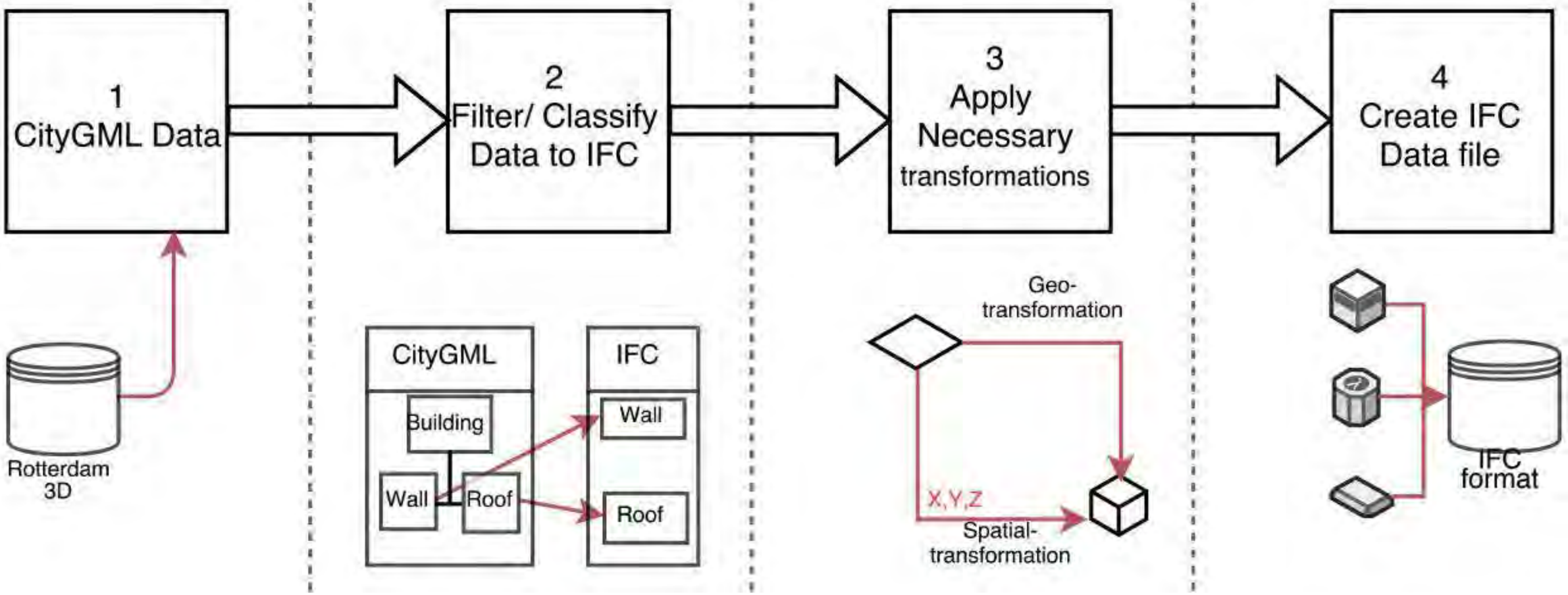




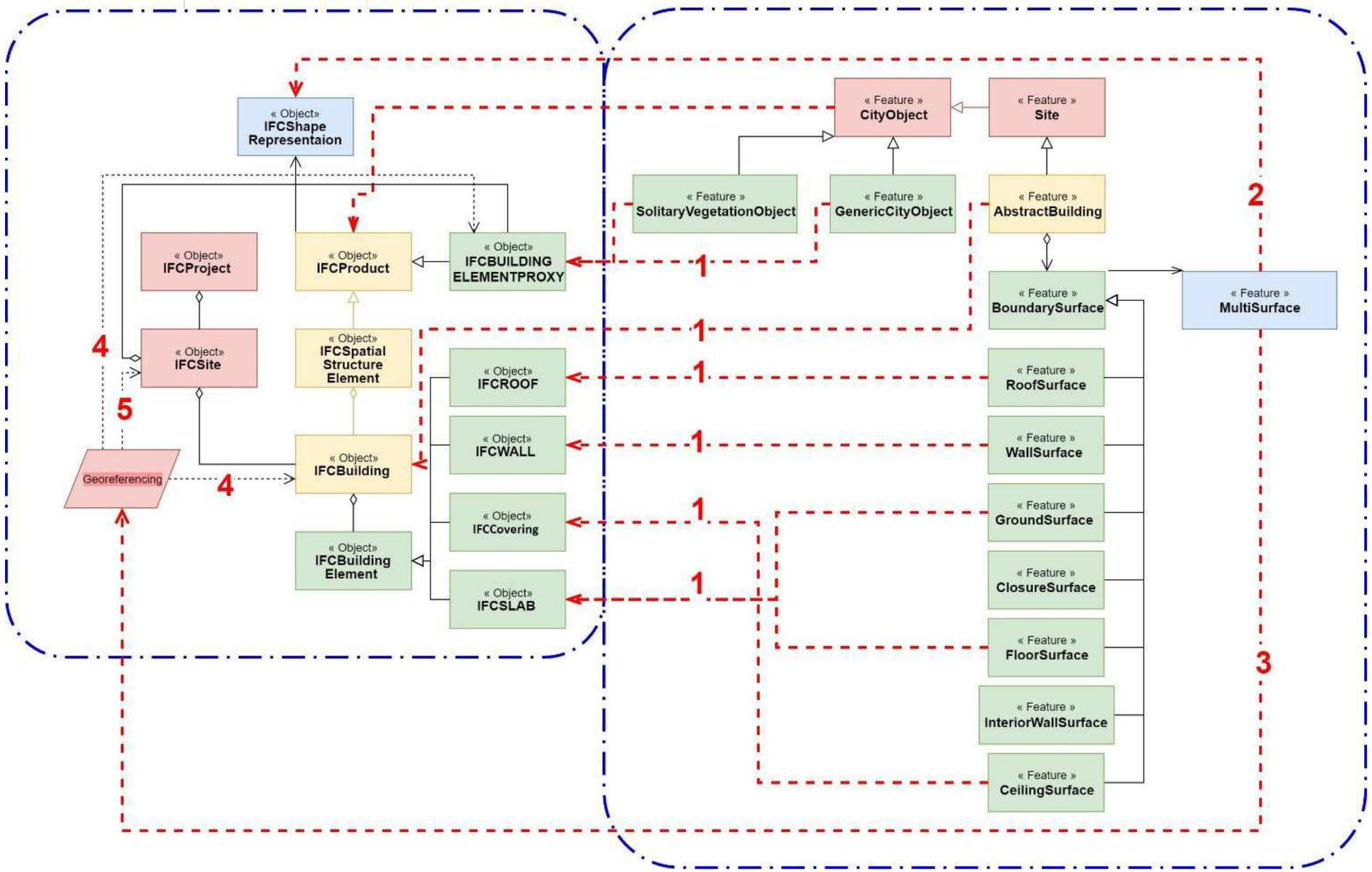
BIM to Geo conversion



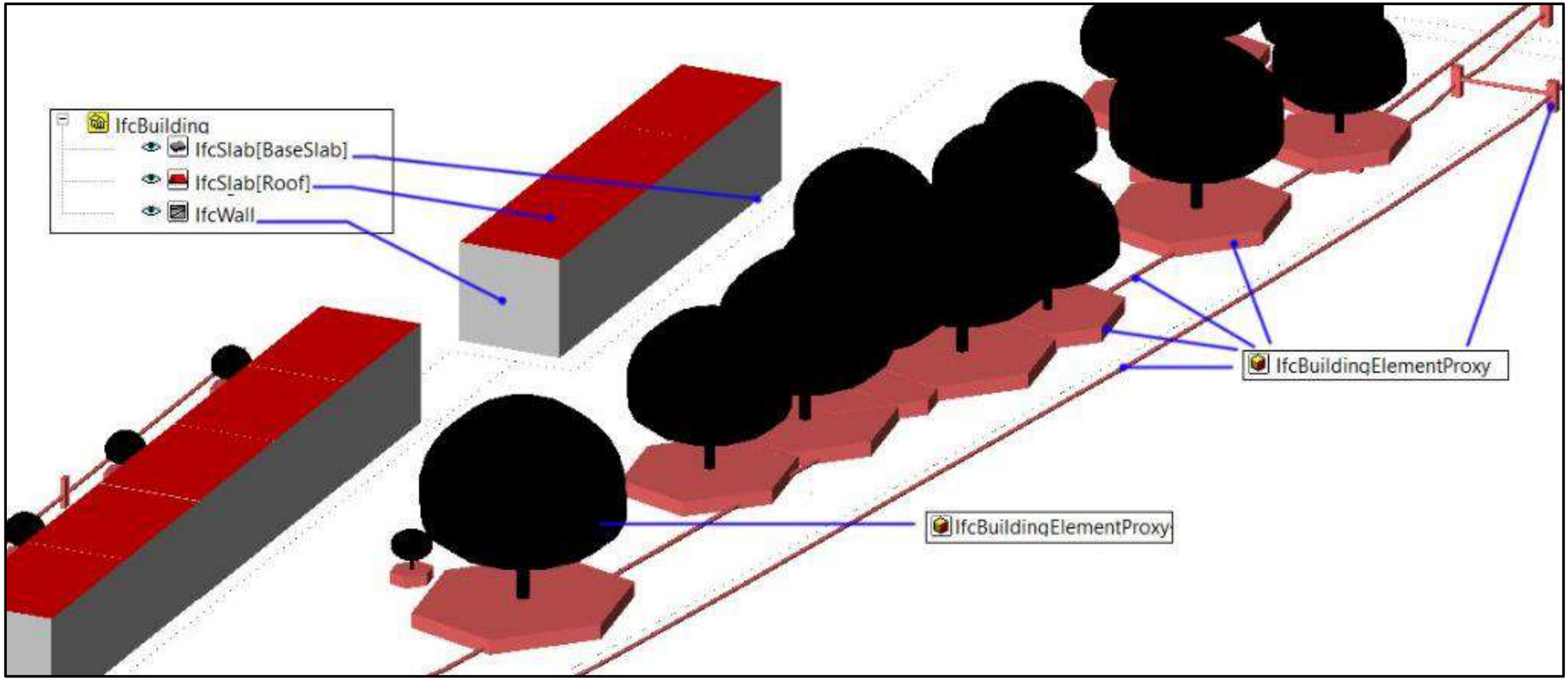
BIM to Geo conversion



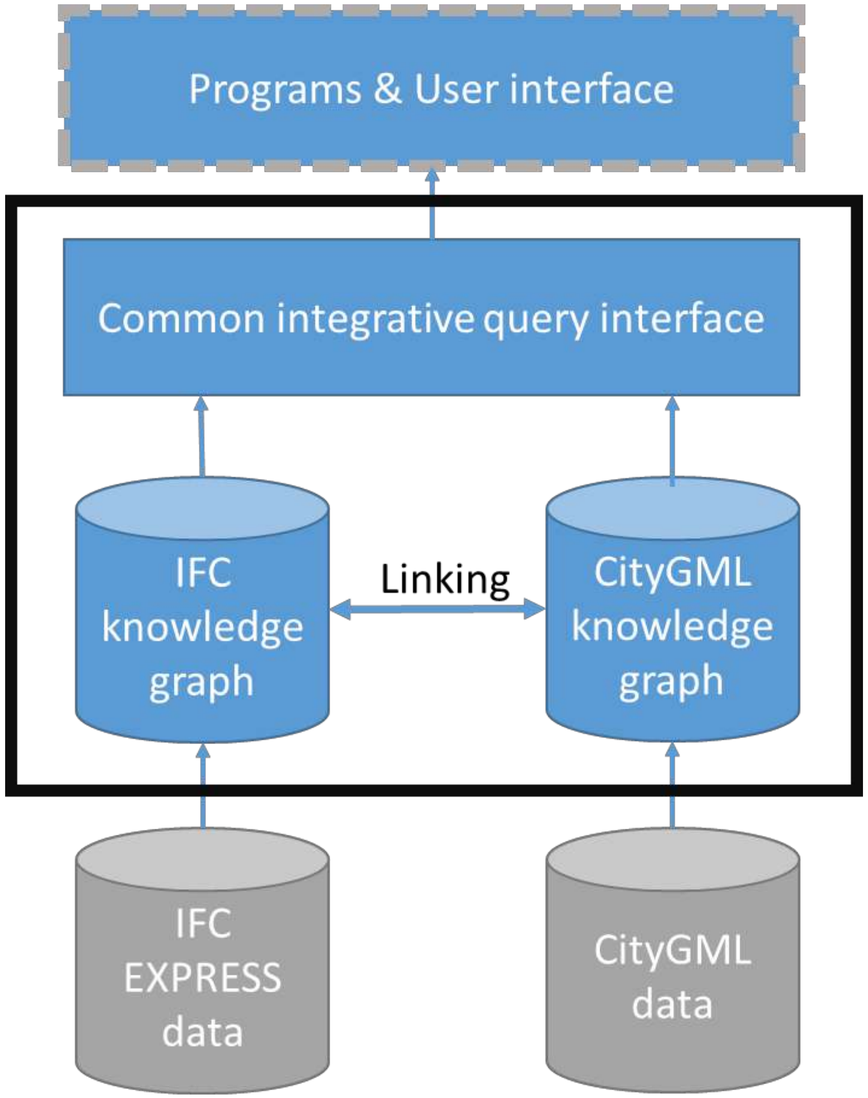
BIM to Geo conversion



BIM to Geo conversion



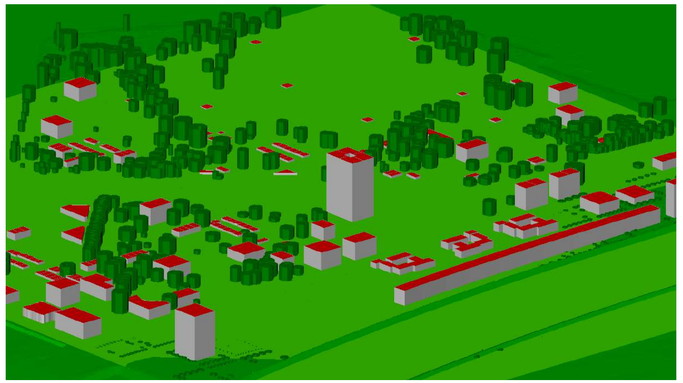
Geo and BIM to another model

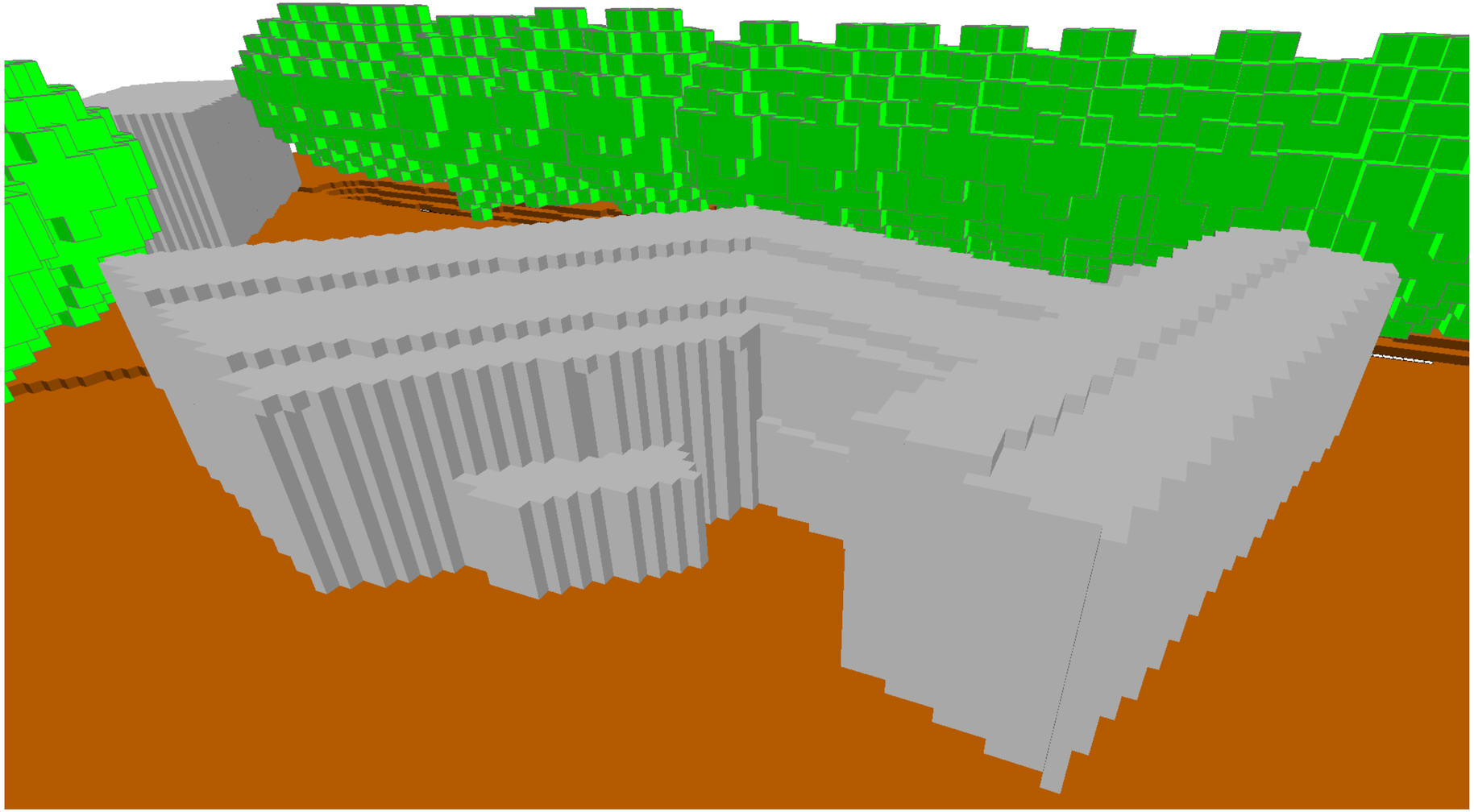


(Huang et al, 2020)

Geo and BIM to another model

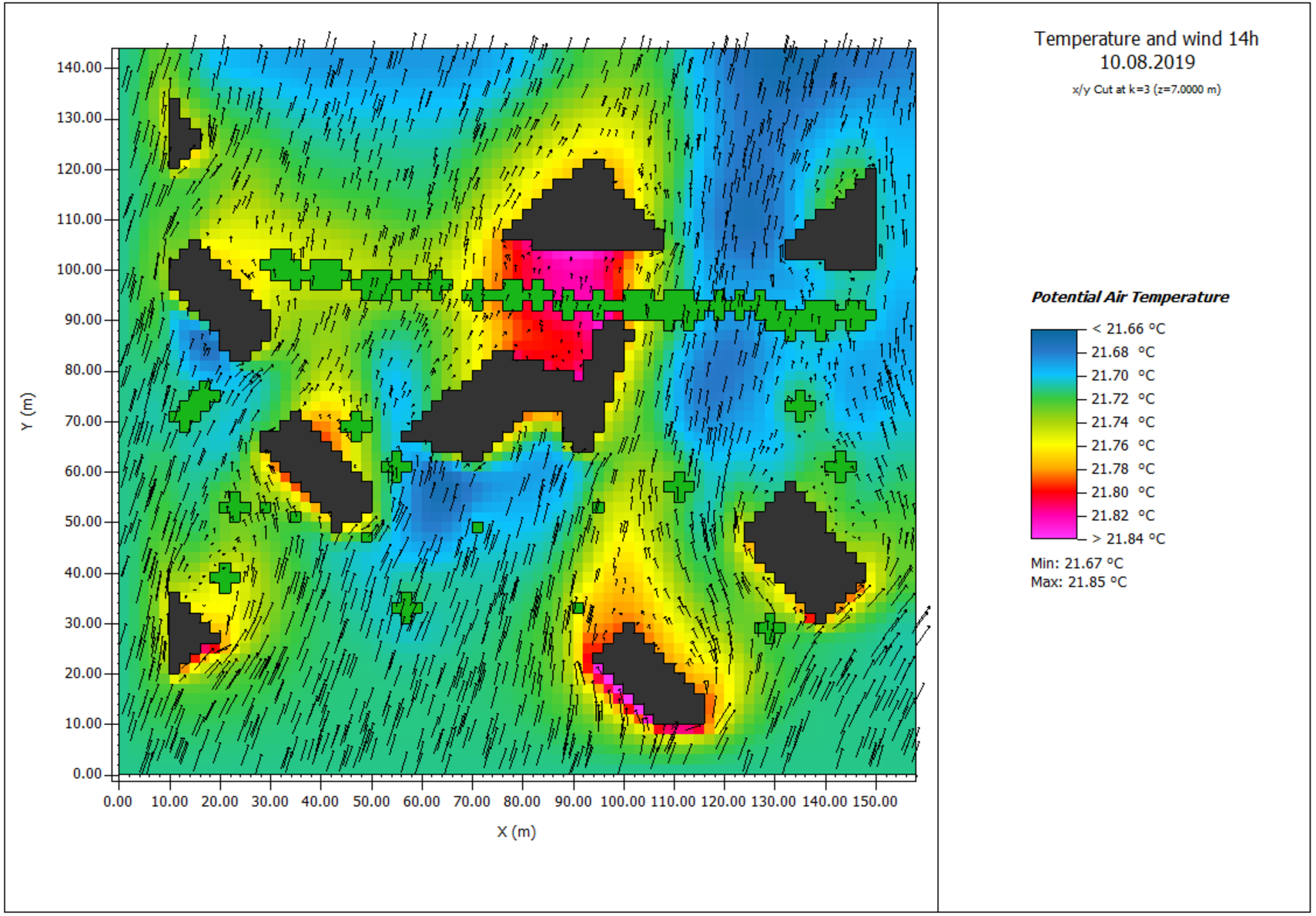






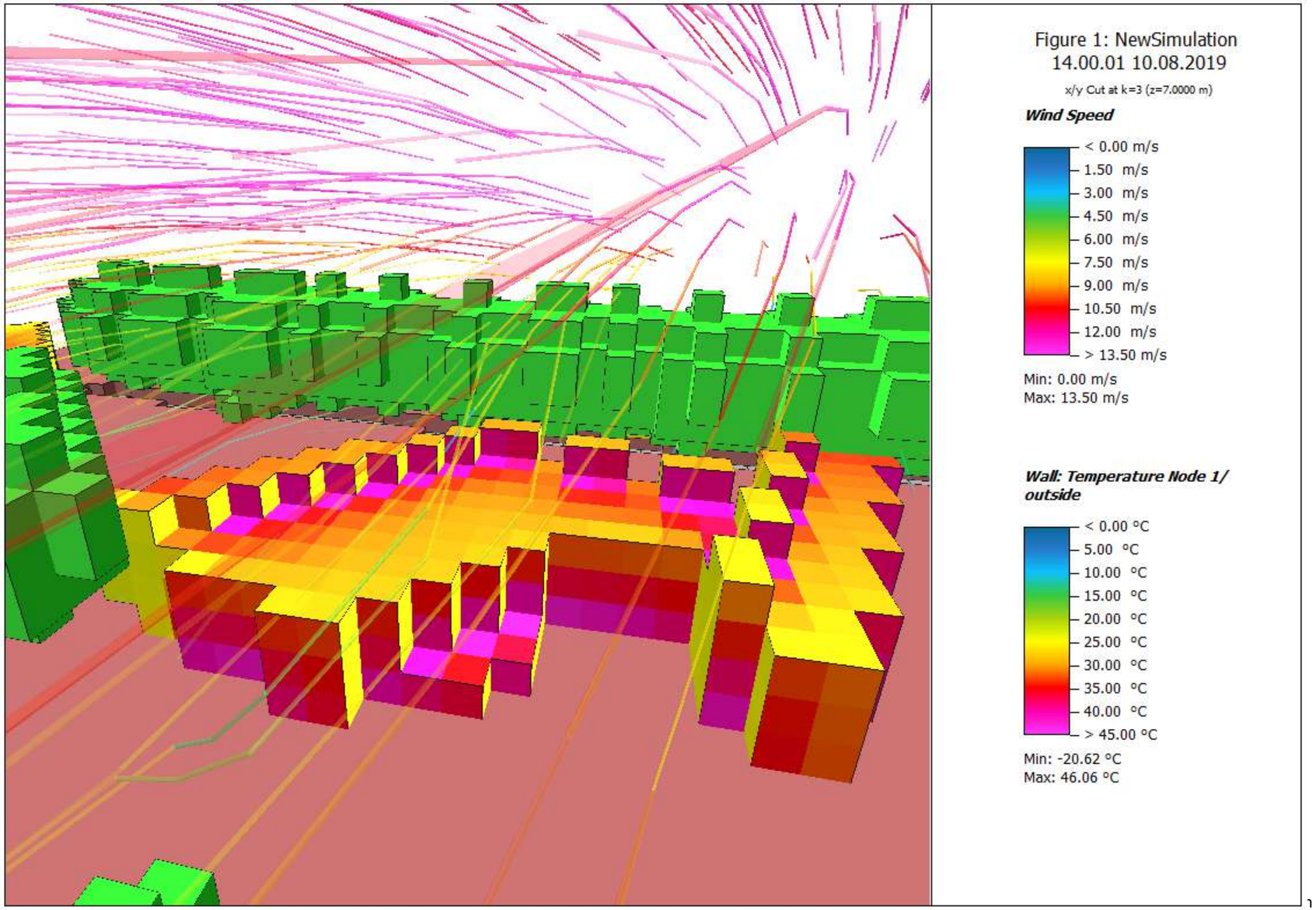
(van Heerden, 2021)

Geo and BIM to another model



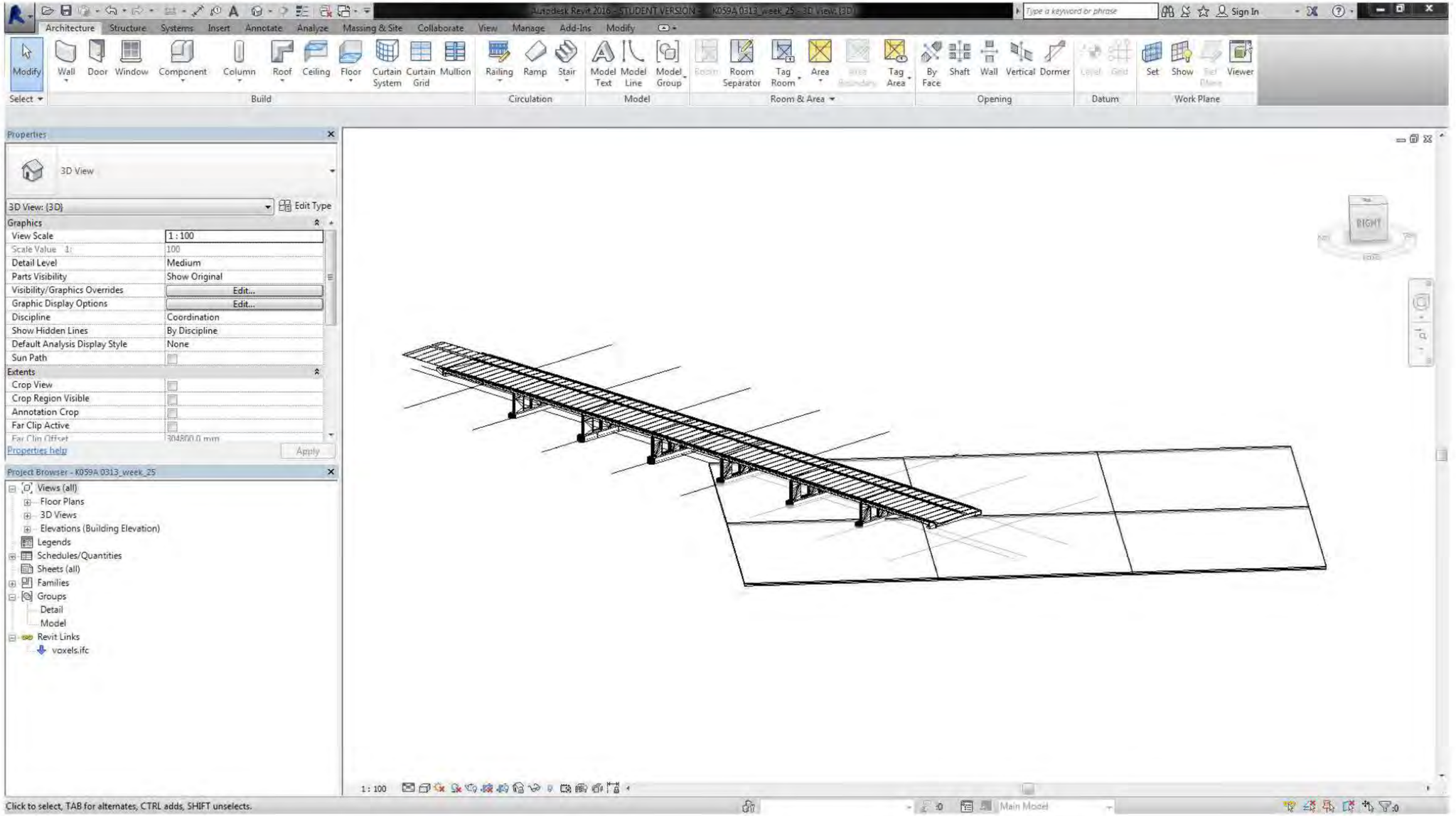
(van Heerden, 2021)

Geo and BIM to another model



ı Heerden, 2021)

Geo and BIM to another model



One last question?....

References

- Axelsson, P. (1999). Processing of laser scanner data—algorithms and applications. ISPRS Journal of Photogrammetry and Remote Sensing 54.2, pp. 138–147.

- Lafarge, F., X. Descombes, J. Zerubia, and M. Pierrot Deseilligny (2010). Structural approach for building reconstruction from a single DSM. IEEE Trans. on Pattern Analysis and Machine Intelligence 32.1, pp. 135–147.

- Automatic conversion of IFC datasets to geometrically and semantically correct CityGML LOD3 buildings. Sjors Donkers, Hugo Ledoux, Junqiao Zhao and Jantien Stoter. Transactions in GIS 20 (4), 2016, pp. 547–569.

- Automatic conversion of CityGML to IFC. Nebras Salheb. Master's thesis, Delft University of Technology, October 2019.

References

- Huang, W., Olsson, P.-O., Kanters, J., and Harrie, L.: RECONCILING CITY MODELS WITH BIM IN KNOWLEDGE GRAPHS: A FEASIBILITY STUDY OF DATA INTEGRATION FOR SOLAR ENERGY SIMULATION, ISPRS Ann. Photogramm. Remote Sens. Spatial Inf. Sci., VI-4/W1-2020, 93–99, https://doi.org/10.5194/isprs-annals-VI-4-W1-2020-93-2020, 2020.

- N.D. van Heerden. BIM and 3D City Models as Input for Microclimate Simulation, Master Thesis, Delft University of Technology, 2021.

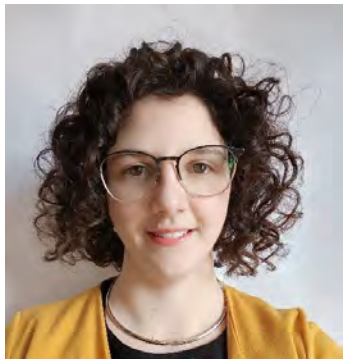
DIGITAL BUILDING PERMIT

Summer School

Module 7 – Interpretation of normative article

10th July 2025

Funded by
the European Union



Sara Comai

Researcher and lecturer at University of Brescia, Italy

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UNIVERSITÀ DEGLI STUDI DI BRESCIA

Tables of content

- Background
- The Legal Documents: Building Regulations and Urban Plan
- Interpretation of normative articles: IR and Logic of verification
- Mapping and standardisation of objects and properties
- Information Requirements structuring in the standards
- Examples

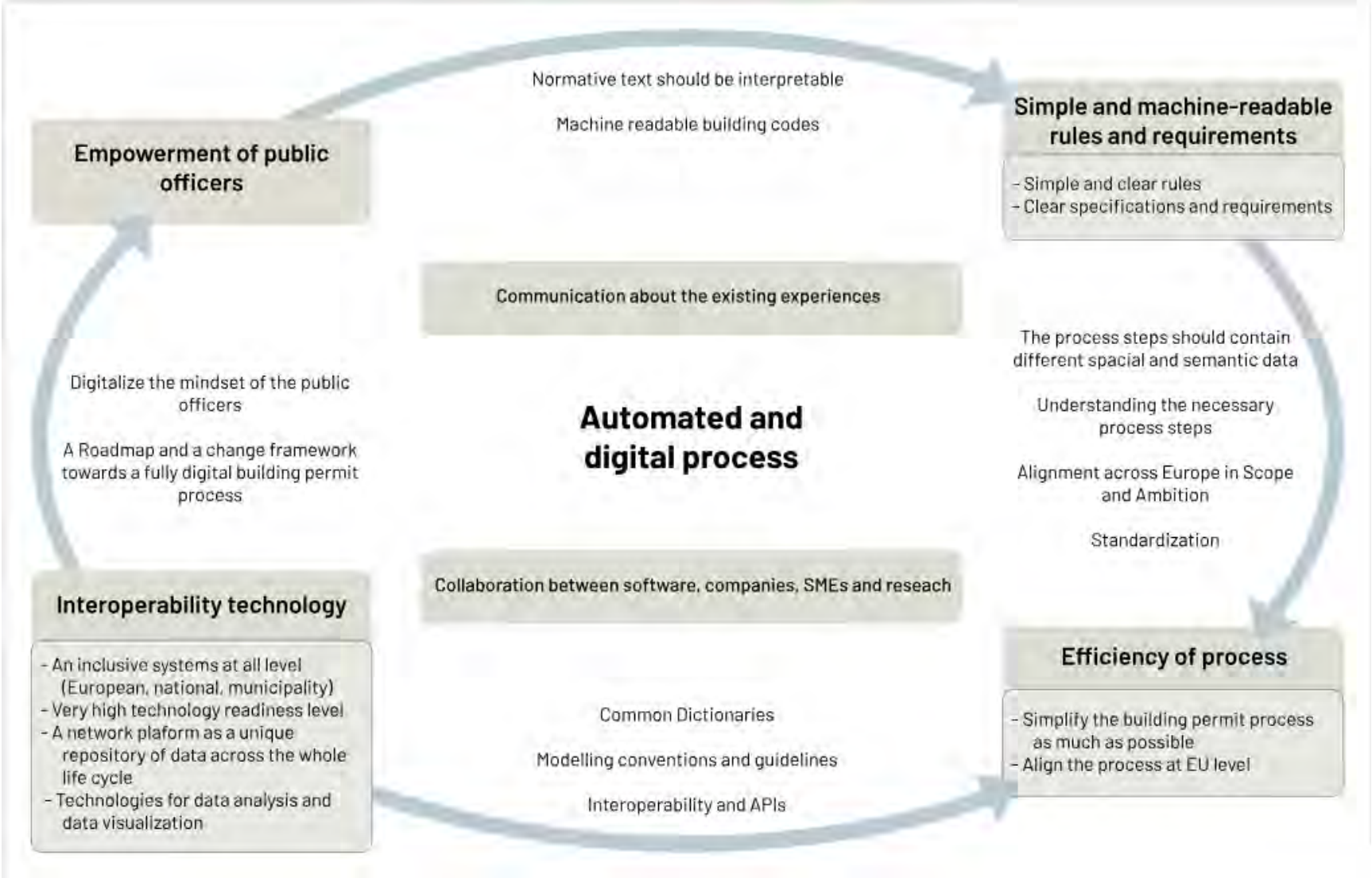
Background

- In 2020, the European Union emphasized the crucial role of the public sector in enabling the dual green and **digital transition** of the construction ecosystem (EU Commission, 2020).

- Implementation of **automated compliance checks** based on rules expressed in machine-readable formats (EU Commission, 2023)

- The digitalisation of **building permits** is therefore a key data-driven strategy expected to promote greater **transparency**, ensure stricter **regulatory compliance** and enable more **efficient collaboration** throughout the entire construction value chain. (EU Commission, 2024)

Background



https://eu4dbp.net/

Background

- The process of compliance checking is done mainly **manually**, causing time dilation and leading to possible errors and inconsistencies (Malsane et al., 2015; Amor and Dimyadi, 2021) that are often due to **ambiguities** and **subjective** interpretation of building regulations (Zhang et al., 2023).

- To pursue automation of this verification process, it is necessary to define the **data** that building regulations require (Noardo et al., 2022a;).

- These data are specified both in the **normative articles** containing the constraints to be met and in the **definitions** of checks types and objects (Mastrolembo Ventura et al., 2023).

The legal documents

	Legal Document
Municipality Level	Building Regulation
	Urban Plan
National Level	Ministerial Decrees

GeoBIM vision





The legal documents

- Ascoli Piceno, Italy
- Vila Nova De Gaia, Portugal
- Lisbon, Portugal
- Prague, Czech Republic

URBAN INDICES
(buildability index; permeable area; covered area; maximum building height; maximum facade height; maximum building length; number of building levels; facade alignment; roof configuration; allowed functions in underground spaces)

DISTANCES
(building-building distance; building-parcel boundaries distance; building-road distance)

BUILDING SPACES
(required building spaces per building type; building spaces requirements for usability (e.g., area, height, window-to-floor area ratio); stairs' requirements (e.g., risers and treads' dimentions and numbers; slope; railings; required forniture and equipment of building spaces; circulation spaces)

PARKING STANDARDS
(Dimensions of parking spaces; number of parking spaces)

ACCESSIBILITY
(e.g., building spaces dimensions, doors' dimensions, circulation spaces' dimension)

BY THIRD PARTIES

ENERGY PERFORMANCE

ACOUSTIC PERFORMANCE

INDOOR/OUTDOOR LIGHTING

VENTILATION

STRUCTURAL ANALYSIS

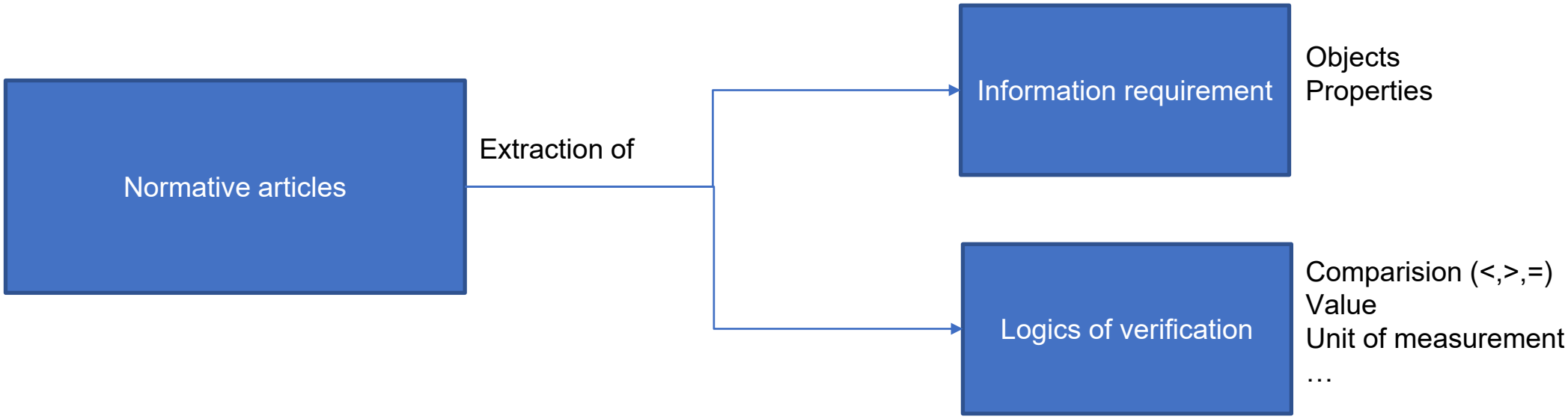
FIRE PREVENTION STANDARDS

HYDROGEOLOGICAL RISK EVALUATION

HYDRAULIC RISK EVALUATION

ENVIRONMENTAL IMPACT ASSESSMENT

Interpretation of normative articles



Interpretation of normative articles

RASE methodology

<r> Requirement

<a> Applicability

<s> Selection

<e> Exception

Requirement: are associated with the future imperatives “shall/must” or “shall/must not”

Applicability: element to which the requirement applies

Selection: what defines applicability

Exception: that which is excluded from check or applicability

- Data Type
- Comparison
- Target/Value
- Unit of measure
- Dependency

The <s> double <s> <a> room <a> <r> must have an area of at least 14 square metres. <r>

Interpretation of normative articles

§57(1)

Garages must have headroom at least 0.2 m greater than the height of the highest expected vehicle, but at least 2.2 m. Along the rear wall of reserved perpendicular or angle parking stalls, the headroom may be reduced to 1.8 m to a depth of 0.7 m.

<R> <a>Garages<a> <r>must have headroom at least 0.2 m greater than the height of the highest expected vehicle<r>,<r> but at least 2.2 m.<r> Along the rear wall of reserved perpendicular or angle parking stalls, the headroom <r> may be reduced to 1.8 m to a depth of 0.7 m. <r> <R>

Art.	Metric Phrase	Type [Rase]
57(1)	Garages	Applicability
	must have headroom at least 0.2 m greater than the height of the highest expected vehicle,	Requirement
	Garages	Applicability
	but at least 2.2 m.	Requirement
	Garages (Along the rear wall of reserved perpendicular or angle parking stalls, the headroom)	Applicability
	may be reduced to 1.8 m to a depth of 0.7 m.	Requirement

Interpretation of normative articles

Art.	Metric Phrase	Type [Rase]
57(1)	Garages	Applicability
	must have headroom at least 0.2 m greater than the height of the highest expected vehicle,	Requirement
	Garages	Applicability
	but at least 2.2 m.	Requirement
	Garages (Along the rear wall of reserved perpendicular or angle parking stalls, the headroom)	Applicability
	may be reduced to 1.8 m to a depth of 0.7 m.	Requirement

Art	Object	Property	Data types	Comparison	Target	Unit of measurement	Dependency
	Space	Intended Use	Alphanumeric	=	Garage		
57 (1)	Space	Height	Number	≥	2.2	m	
	Space	Height (distance from vehicle to ceiling)	Number	≥	0.2	m	
	Space	Height	Number	≥	1.8	m	Along the rear wall of reserved perpendicular or angle parking stalls, the headroom
	Space	Depth (Height 1.8m)	Number	≤	0.7	m	

Interpretation of normative articles

§58(1)
The edge of accessible walking areas of a building adjacent to open space must have a protective railing or other fall protection barrier. Parameters are stipulated by values listed in point 7 of Annex 1 to this Ordinance. This requirement does not apply to areas that are accessible only for their maintenance.

<R> <a>The edge<a> <s>of accessible walking areas of a building adjacent to open space <s> <r> must have a protective railing or other fall protection barrier.<r> Parameters are stipulated by values listed in point 7 of Annex 1 to this Ordinance. <e> This requirement does not apply to areas that are accessible only for their maintenance.<e> <R

Art.	Metric Phrase	Type [Rase]
58 (1)	The edge	Applicability
	of accessible walking areas of a building adjacent to open space	Selection
	must have a protective railing or other fall protection barrier.	Requirement
	This requirement does not apply to areas that are accessible only for their maintenance.	Exception

Interpretation of normative articles

Art.	Metric Phrase	Type [Rase]
58 (1)	The edge	Applicability
	of accessible walking areas of a building adjacent to open space	Selection
	must have a protective railing or other fall protection barrier.	Requirement
	This requirement does not apply to areas that are accessible only for their maintenance.	Exception



Art.	Object	Property	Data types	Comparison	Target	Unit of measure	Dependency
58 (1)	Edge (accessible walking areas)						This requirement does not apply to areas that are accessible only for their maintenance.
	Railing	Exist	Boolean	Yes/No	Yes		

Interpretation of normative articles

Information requirements

Logics of verification

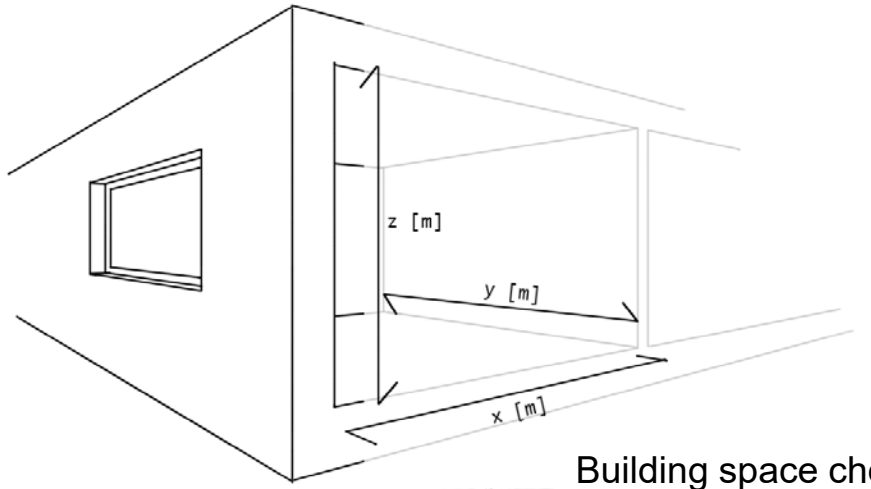
Art	Object	Property	Data types	Comparison	Target	Unit of measure	Dependency
	Space	Intended Use	Alphanumeric	=	Garage		
57 (1)	Space	Height	Number	≥	2.2	m	
	Space	Height (distance from vehicle to ceiling)	Number	≥	0.2	m	
	Space	Height	Number	≥	1.8	m	Along the rear wall of reserved perpendicular or angle parking stalls, the headroom
	Space	Depth (Height 1.8m)	Number	≤	0.7	m	

Mapping and standardisation of objects and properties

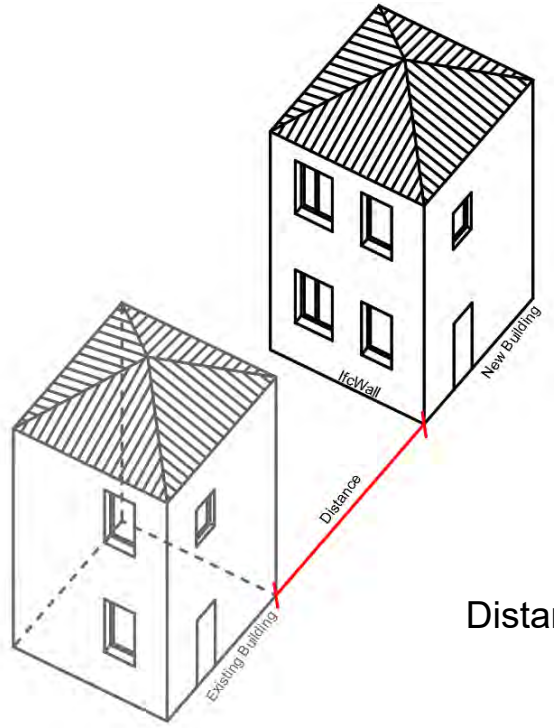
What domain does it belong to?

For which checks do I need the object?

Object	BIM	GIS
Wall	X	X
Partitional wall	X	
Space	X	
Roof	X	X
Existing building		X
Road		X



Building space checks



Distance checks

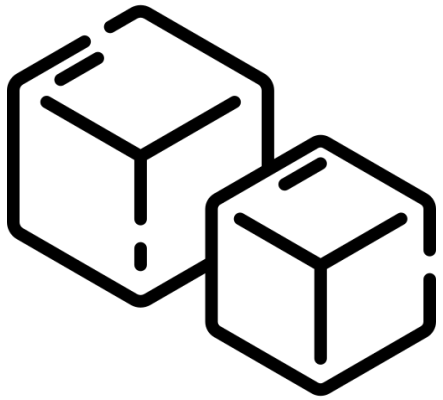
Mapping and standardisation of objects and properties

buildingSMART International

The IFC implementation significantly enhances the accessibility and query-ability of architectural information (Eastman et al., 2010; Wong and Lee, 2022)

BuildingSMART International also introduced the **Information Delivery Specification (IDS)**, an open standard to connect the definition of information requirements with their verification. (buildingSMART International, 2024)

IDS serves as a computer-readable schema for semantic **alphanumeric information** requirements (Fischer et al., 2024)



Mapping and standardisation of objects and properties

buildingSMART International

IFC4 ADD2 TC1 Schema → ISO 16739:2018

Georeference

It has advantages when combining building model and GIS

Information Requirements	IFC4 ADD2 TC1 Schema	Property
Wall	IfcWall	Pset_WallCommon.IsExternal

IFC

IDS

[...]

<specifications>

<specification name="Each wall should have Pset_WallCommon.IsExternal property" ifcVersion="IFC4" minOccurs="0" maxOccurs="unbounded">

[...]

Object

Property

Mapping and standardisation of objects and properties

CITYGML

Information Requirements	CityJSON Class	CityJSON Module	CityJSON Property
Existing building - legalHeight	Building	Building Extension	+LegalHeight

INSPIRE

Information Requirements	INSPIRE Class	INSPIRE Theme Module	INSPIRE Property
Cadastral parcel	CadastralZoning	CadastralParcel	-
Urban Zone	ZoningElement	PlannedLandUse	-

Information Requirements structuring in the standards

ISO 7817-1
describe Information Requirements through the integration of **geometrical information**, **alphanumerical information** and **documentation**

ISO 23386
ensures semantic consistency and the possibility of linking defined information requirements with existing **data dictionaries**

ISO 19650-4
allows defining the actors involved in information exchange, clarifying the roles of information providers and receivers, and ensuring that the exchange of structured information follows a coordinated path.

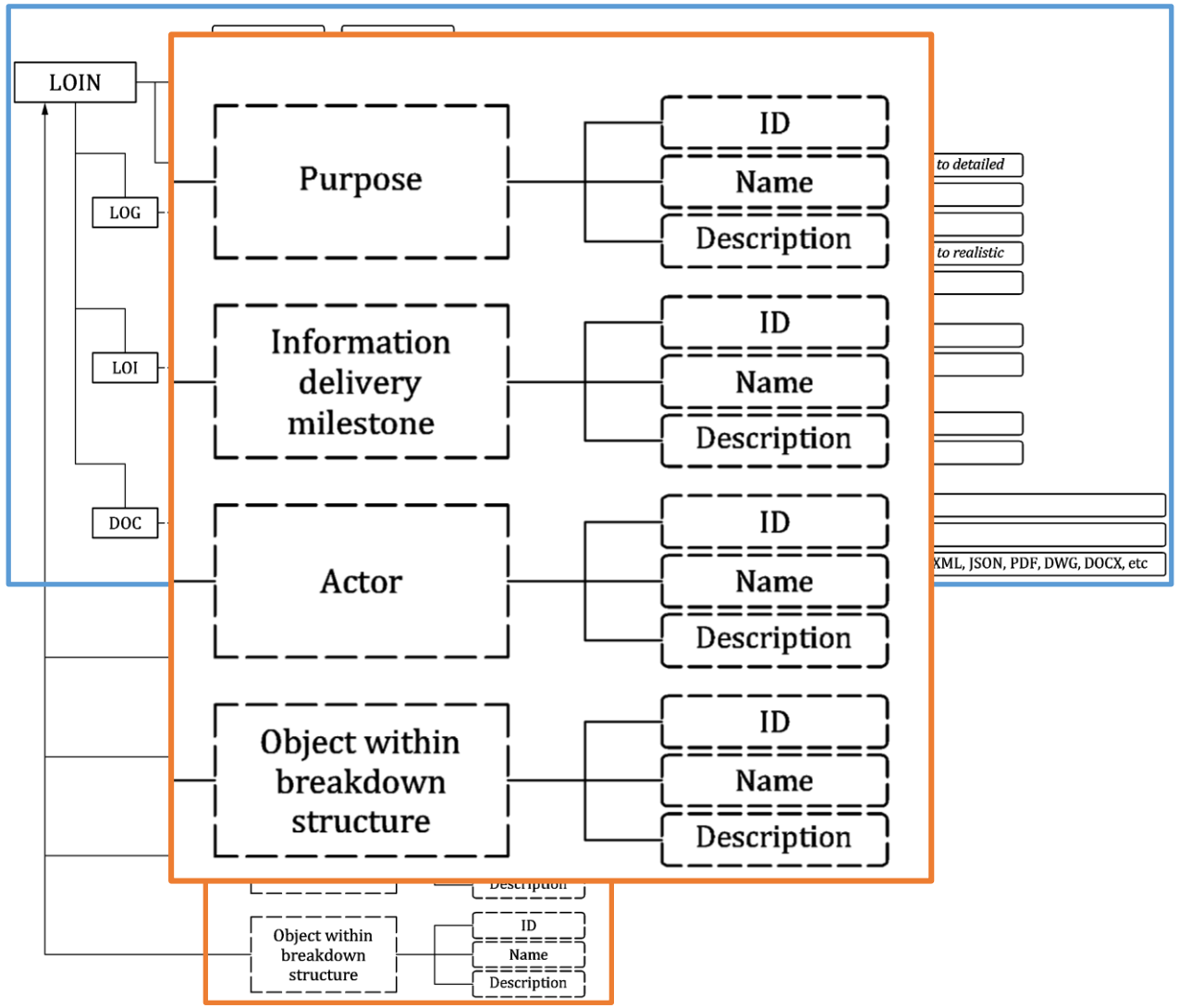
Information Requirements structuring in the standards

Prerequisites:

- Why – Purposes
- When – Information Delivery Milestone
- Who – Actors [ISO 19650-4]
- What – Object

Level of Information Need:

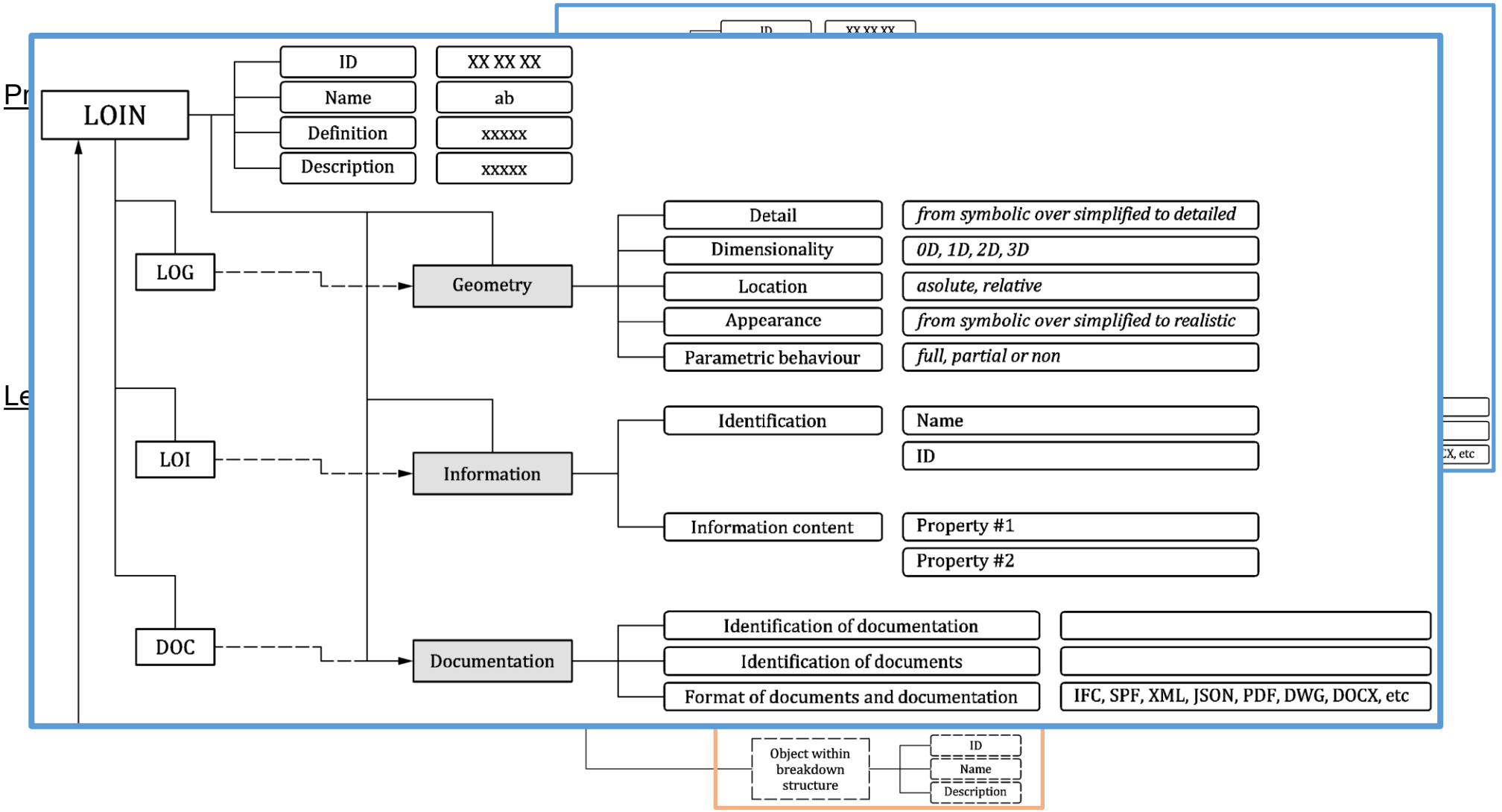
- Geometrical Information
- Alphanumerical Information
- Documentation



[Level of Information Need framework, ISO 7817,2024]

Information Requirements structuring in the standards

Information Requirements structuring in the standards



[Level of Information Need framework, ISO 7817,2024]

Examples

Municipality of Ascoli Piceno, Italy

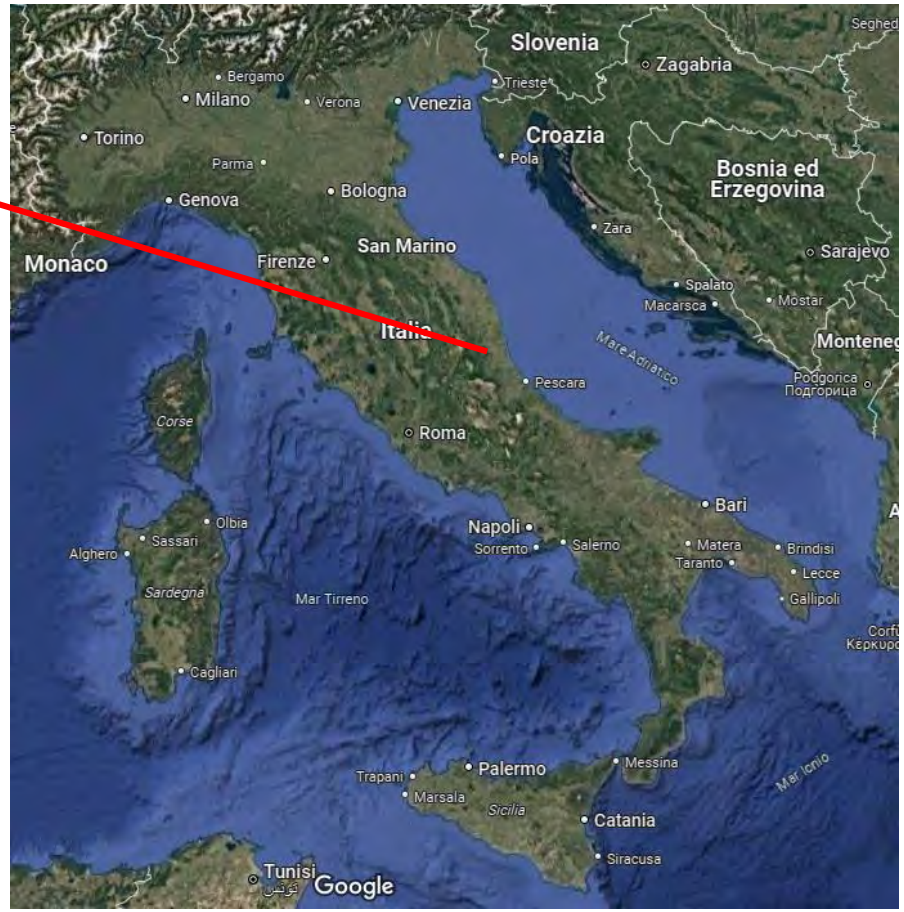
Document legal:

- Building Regulation
- Technical implementing regulations

Normative articles
Definition of checks

Extraction of

Information Requirements



Technical Implementation Regulations

Art. 48 - Predominantly high-density residential fabric [...]

Maximum building height: 15,00 m [...]

Maximum building height

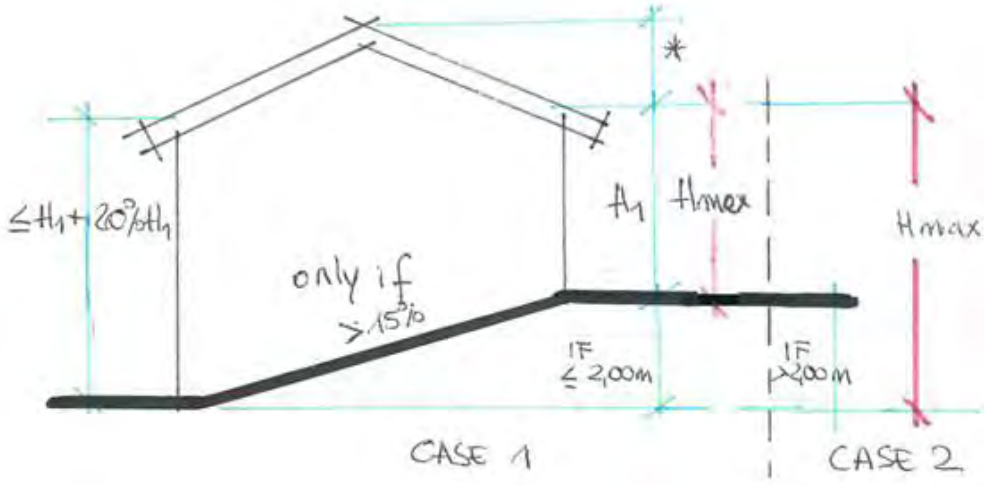
Information Requirements | *Logic of verification*

					Resulting interpretation				
Normative clause (ITA-ENG language) (Norme Tecniche di Attuazione of the Mucnicipality of Ascoli Piceno - Art. 48)	**Metric phrase**	**Mark-up (RASE)**	**Object (building/city model)**	**Property**	**Data type**	**Comparison**	**Target (value)**	**Unit of measurement**	**Dependency**
Predominantly high-density residential fabric Maximum building height: 15,00 m	Predominantly high-density residential fabric	Selection	Urban Zone	Intended Use	Alphanumeric	=	Predominantly high-density residential		
	Building	Applicability	Building						
	Maximum height: 15,00 m	Requirement	Building	Height	Numeric	≤	15	m	IF Urban zone Intended Use is Predominantly high-density residential

Examples

Building regulation
Art. 13 (n) - Maximum height of buildings (HMAX) –

This is the maximum between the heights of the different parts of the elevation into which the building can be divided, measured as in letter m) above. In the case of elevations in which there are inclined roof pitches (gabled, staggered or single-pitched), the maximum height is considered to be that corresponding to the intersection of the elevation walls with the plane corresponding to the extrados of the roof pitch (1) as long as the ridge does not exceed the height measured in this way by more than 1.80 m, otherwise the maximum height is measured at the ridge line. (2) If the roof slopes coincide with the sloping walls of the elevations, the maximum height must always be measured to the ridge line. (3) For buildings on land with a natural slope of more than 15%, the maximum height permitted by the town planning instruments, unless more restrictive prescriptions of the same, may be exceeded by 20% in the downstream parts of the elevations, with an absolute maximum of 2.00.



Examples

Information Requirements	IFC4 ADD2 TC1 Schema	Property
Building	IfcBuilding	CHEK_common.TypeOfConstruction
		Pset_BuildingUse.MarketCategory
		CHEK_common.Height
Wall	IfcWall	Pset_WallCommon.IsExternal
Roof	IfcRoof	-

Extension of the schema CHEK_

IFC

IDS

[...]

</specification>

<specification name="Each building should have Pset_BuildingUse.MarketCategory property" ifcVersion="IFC4" minOccurs="0" maxOccurs="unbounded">

[..]

</specification>

<specification name="Each building should have CHEK_common.Height property" ifcVersion="IFC4" minOccurs="0" maxOccurs="unbounded">

[...]

<specifications>

<specification name="Each wall should have Pset_WallCommon.IsExternal property" ifcVersion="IFC4" minOccurs="0" maxOccurs="unbounded">

[...]

</specification>

<specification name="Roof Exists" description="There should be at least one instance of IFCROOF entity" instructions="Make sure that the Roof is modelled as a roof, it might be modelled as a single roof object or as a decomposed structure where a roof is decomposed into individual slabs" ifcVersion="IFC4" minOccurs="1" maxOccurs="unbounded">

Examples

Information Requirements	CityJSON Class	CityJSON Module	CityJSON Property
Existing building - legalHeight	Building	Building Extension	+LegalHeight

Information Requirements	INSPIRE Class	INSPIRE Theme Module	INSPIRE Property
Cadastral parcel	CadastralZoning	CadastralParcel	-
Urban Zone	ZoningElement	PlannedLandUse	-
Urban Zone - Zone	ZoningElement	PlannedLandUse	specificLandUse
Max allowed building height	OfficialDocumentation	PlannedLandUse extension	Max allowed building height
Plot	Part of ZoningElement	PlannedLandUse extension	-

Examples

Distances

Technical Implementation Regulations

Art. 48 - Predominantly high-density residential fabric [...]

Minimum building-to-building distance: 10,00 m

Information Requirements *Logic of verification*

					Resulting interpretation				
Normative clause (ITA-ENG language) (Norme Tecniche di Attuazione of the Mucnicipality of Ascoli Piceno - Art. 48)	**Metric phrase**	**Mark-up (RASE)**	**Object (building/city model)**	**Property**	**Data type**	**Comparison**	**Target (value)**	**Unit of measurement**	**Dependency**
Predominantly high-density residential fabric Minimum building-to-building distance: 10,00 m Minimum distance from the boundaries: 5,00 m	Predominantly high-density residential fabric	Selection	Urban Zone	Intended Use	Alphanumeric	=	Predominantly high-density residential		
	Building	Applicability	Building						
	Existing building								
	Minimum distance [building-to-building]: 10,00 m	Requirement	Building	Height	Numeric	≤	15	m	IF Urban zone Intended Use is Predominantly high-density residential

Examples

Technical Implementation Regulations

Art. 48 - Predominantly high-density residential fabric [...]

Minimum distance from the boundaries: 5,00 m

Distances

Information Requirements *Logic of verification*

					Resulting interpretation				
Normative clause (ITA-ENG language) (Norme Tecniche di Attuazione of the Mucnicipality of Ascoli Piceno - Art. 48)	**Metric phrase**	**Mark-up (RASE)**	**Object (building/city model)**	**Property**	**Data type**	**Comparison**	**Target (value)**	**Unit of measurement**	**Dependency**
	Predominantly high-density residential fabric	Selection	Urban Zone	Intended Use	Alphanumeric	=	Predominantly high-density residential		
	Building	Applicability	Building						
	Existing building								
Predominantly high-density residential fabric Minimum building-to-building distance: 10,00 m Minimum distance from the boundaries: 5,00 m	Minimum distance [building-to-parcel boundaris]: 5,00 m	Requirement	Building	Distance	Numeric	≤	5	m	IF Urban zone Intended Use is Predominantly high-density residential

Examples

Building regulation - Art. 13 (o) - Building-Building distance - Is the distance (minimum) between the walls in front of the buildings, or buildings of the same, except for the walls on the interior spaces referred to in point (r) below, measured at the points of maximum protrusion. Two walls are considered to be facing when the angle formed by the extension of the same is less than 70 degrees sexagesimal and the overlap is greater than 1/4 of the minimum distance of the walls themselves.

Building regulation - Art. 13 (p) - Building-parcel boundaries distance - It is the distance between the vertical projection of the wall of the building and the boundary line, measured at the point of maximum protrusion. It is understood as a border beyond the separation line of the different existing properties or the line defining the different lots or compartments of the implementation plans, as well as the line of delimitation of public areas for services or equipment identified in urban planning instruments.

Building regulation - Art. 13 (q) - Building-road distance - It is the distance between the vertical projection of the wall of the building and the edge of the road, including sidewalk and public parking and road furniture areas.

Examples

Information Requirements	IFC4 ADD2 TC1 Schema	Property
Building	IfcBuilding	CHEK_common.TypeOfConstruction
		Pset_BuildingUse.MarketCategory
		CHEK_common.Height
Wall	IfcWall	Pset_WallCommon.IsExternal
Window	IfcWindow	-

Extension of the schema
CHEK_

IFC

IDS

[...]

</specification>

<specification name="Each building should have Pset_BuildingUse.MarketCategory property" ifcVersion="IFC4" minOccurs="0" maxOccurs="unbounded">

[..]

</specification>

<specification name="Each building should have CHEK_common.Height property" ifcVersion="IFC4" minOccurs="0" maxOccurs="unbounded">

[...]

<specifications>

<specification name="Each wall should have Pset_WallCommon.IsExternal property" ifcVersion="IFC4" minOccurs="0" maxOccurs="unbounded">

[...]

</specification>

<specification name="Window Exists" description="There should be at least one instance of IFCWINDOW entity" instructions="Make sure that the Window is modelled as a IFCWINDOW" ifcVersion="IFC4" minOccurs="1" maxOccurs="unbounded">

[...]

Object	CityJSON Class	CityJSON Module	CityJSON Property
Existing building – legalHeight	Building	Building Extension	+LegalHeight
Existing building - Facade	WallSurface	Building	semanticSurface
Existing building - Facade - hasWindows	WallSurface	Building Extension	+hasWindows
Road	Road	Transportation Extension	+Function - road
Sidewalk	Road	Transportation Extension	+Function - sidewalk
Road furniture areas	Road	Transportation Extension	+Function - road furniture
Public Parking	Road	Transportation Extension	+Function - public parking
Green public spaces	PlantCover	-	-
New Building	Building	-	-
New building - Facade	WallSurface	Building	semanticSurface
New building - Facade - hasWindows	WallSurface	Building Extension	+hasWindows

CityGML

Examples

Information Requirements	INSPIRE Class	INSPIRE Theme Module	INSPIRE Property
Cadastral parcel	CadastralZoning	CadastralParcel	-
Urban Zone	ZoningElement	PlannedLandUse	-
Urban Zone - Zone	ZoningElement	PlannedLandUse	specificLandUse
Utilities (sewerage, water, etc.)	ZoningElement	LandUse	specificLandUse
Min Building-building Distance (m)	OfficialDocumentation	PlannedLandUse extension	Min Building-building Distance
Min Building- parcel border Distance	OfficialDocumentation	PlannedLandUse extension	Min Building- parcel border Distance
Plot	Part of ZoningElement	PlannedLandUse extension	-

INSPIRE

Examples

Example 1 – Wall and Cadastral Parcel objects

Prerequisites						
Why		When	Who		Wha	What
High level purpose	Purposes	Information Delivery Milestone	Actor(s) ISO 19650-4		Ob	Object
			Information provider	Information receiver		
Digital Building Permit	Maximum building height - Distances	Design - Delivery plan	Designers	Municipal experts	W	CADASTRAL PARCEL

Examples

Example 1 - WALL OBJECT

How									
Level of Information Need									
Geometrical information	Detail	The wall must be modelled with a simplified geometry, with a single shape. Its geometric representation is influenced by adjacent objects, so a basic fitting operation is required (must include connection). No need for operating zones. It is not necessary to go into detail about the stratigraphy of the element. There is no need to further articulate the features of the wall with decorative elements.							
	Dimensionality	3D							
	Location	Absolute - CRS - EPSG:3004							
	Appearance	Not requested							
	Parametric behaviour	Not requested							
Alphanumerical information	Identification	*buildingSMART Data Dictionary*							ISO 23386
		WALL - IfcWall [https://standards.buildingsmart.org/IFC/RELEASE/IFC4/ADD2_TC1/HTML/link/ifcwall.htm]							
	Information content	Code	Name	Description	Example	Interconnected data dictionaries management rule	Request from management rule	Type	List of values
		PA01	Globally unique identifier	Globally unique identifier	538b13b8-7bfe-4105-ab87-12dfcc4b859d	Mandatory Calculated	Not relevant	String Single-value	-
		PA02	IsExternal	Given that it defines the function of the wall. It distinguishes the perimeter wall from the interior wall	Yes	Mandatory	Mandatory	List Single-value	Yes No
Documentation	Set of documents		Not requested						

Examples

Example 1 - WALL OBJECT

Prerequisites						Level of information need									
Why		When	Who		What	How									
High level purpose	Purposes	Information Delivery Milestone	Actor(s) ISO 19650-4		Object	Level of Information Need									
			Information provider	Information receiver											
Digital Building Permit	Maximum building height - Distances	Design - Delivery plan	Designers	Municipal experts	WALL	Geometrical information	Detail	The wall must be modelled with a simplified geometry, with a single shape. Its geometric representation is influenced by adjacent objects, so a basic fitting operation is required (must include connection). No need for operating zones. It is not necessary to go into detail about the stratigraphy of the element. There is no need to further articulate the features of the wall with decorative elements.								ISO 23386
							Dimensionality	3D							
							Location	Absolute - CRS - EPSG:3004							
							Appearance	Not requested							
							Parametric behaviour	Not requested							
						Alphanumerical information	Identification	buildingSMART Data Dictionary							
								WALL - IfcWall [https://standards.buildingsmart.org/IFC/RELEASE/IFC4/ADD2_TC1/HTML/link/ifcwall.htm]							
							Information content	Code	Name	Description	Example	Interconnected data dictionaries management rule	Request from management rule	Type	List of values
								PA01	Globally unique identifier	Globally unique identifier	538b13b8-7bfe-4105-ab87-12dfcc4b859d	Mandatory Calculated	Not relevant	String Single-value	-
								PA02	IsExternal	Given that it defines the function of the wall. It distinguishes the perimeter wall from the interior wall.	Yes	Mandatory	Mandatory	List Single-value	Yes No
						Documentation	Set of documents		Not requested						

Examples

Example 2 – Cadastral Parcel object

How										
Level of Information Need										
Geometrical information	Detail	The cadastral parcel must be modelled as a contour primitive. It must contain any changes in elevation. Its geometric representation is not affected by the presence of adjacent objects, so a basic linking operation is not required. No operational zones are required. The stratigraphy of the element is not required. It is not necessary to further articulate the features of the cadastral parcel.								
	Dimensionality	2D								
	Location	Absolute - CRS - EPSG:3004								
	Appearance	Not requested								
	Parametric behaviour	Not requested								
Alphanumerical information	Identification	INSPIRE Feature Concept Dictionary and buildingSMART Data Dictionary								
		Cadastral Parcel [http://inspire.ec.europa.eu/featureconcept/CadastralZoning]								
	Information content	Code	Name	Description	Example	Interconnected data dictionaries management rule	Request from management rule	Type	List of values	
		PA01	Globally unique identifier	Globally unique identifier	538b13b8-7bfe-4105-ab87-12dfcc4b859d	Mandatory Calculated	Not relevant	String Single-value	-	
Documentation	Set of documents		Not requested							

ISO 23386

Examples

Example 2 – Cadastral Parcel object

Prerequisites						Level of information need									
Why		When	Who		What	How									
High level purpose	Purposes	Information Delivery Milestone	Actor(s) *ISO 19650-4*		Object	Level of Information Need									
			Information provider	Information receiver											
Digital Building Permit	Maximum building height - Distances	Design - Delivery plan	Designers	Municipal experts	CADASTRAL PARCEL	Geometrical information	Detail	The cadastral parcel must be modelled as a contour primitive. It must contain any changes in elevation. Its geometric representation is not affected by the presence of adjacent objects, so a basic linking operation is not required. No operational zones are required. The stratigraphy of the element is not required. It is not necessary to further articulate the features of the cadastral parcel.								ISO 23386
							Dimensionality	2D							
							Location	Absolute - CRS - EPSG:3004							
							Appearance	Not requested							
							Parametric behaviour	Not requested							
						Alphanumerical information	Identification	INSPIRE Feature Concept Dictionary and buildingSMART Data Dictionary							
								Cadastral Parcel [http://inspire.ec.europa.eu/featureconcept/CadastralZoning]							
							Information content	Code	Name	Description	Example	Interconnected data dictionaries management rule	Request from management rule	Type	List of values
								PA01	Globally unique identifier	Globally unique identifier	538b13b8-7bfe-4105-ab87-12dfcc4b859d	Mandatory Calculated	Not relevant	String Single-value	-
						Documentation	Set of documents		Not requested						

Thank you for your attention

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Fraunhofer ITALIA

DIGITAL BUILDING PERMIT

Summer school 2025

M08 - Interpretation of Regulations Workshops

Open AI: Customizing an AI agent for building permit interpretation

10th July 2025

Funded by
the European Union

1. The need for translation and interpretation



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Fraunhofer
ITALIA

1. The need for translation and interpretation

Information requirements for the DBP use case

Interpret and formalise the **building permit regulations:**

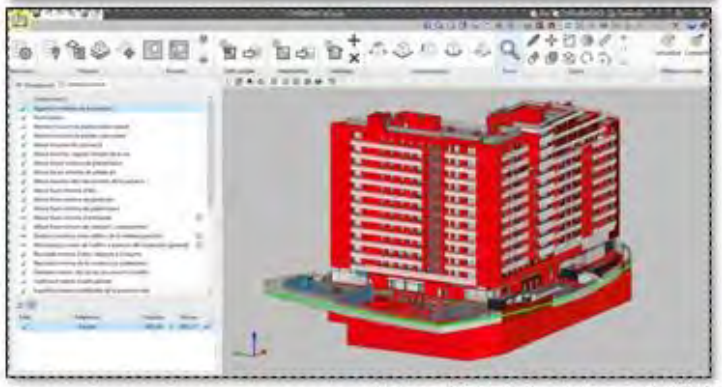
(1) to translate them into machine-readable rules in code checking software and;

(2) to define the information requirements for the creation of building and city models in standard formats

Eastman et al. (2009)







Source: Virtual city system and CYPE

2. Accessibility regulation interpretation

Collection of building permit regulations

CHEK ADDED VALUE: the **GeoBIM APPROACH**

35 clauses

CATEGORIES OF BUILDING PERMIT CHECKS		
BUILDING-URBAN DATA	**DISTANCES** (building-building distance; building-parcel boundaries distance; building-road distance)	MAJOR BOTTLENECK
	BUILDING HEIGHT	MAJOR BOTTLENECK
	URBAN INDICES (buildability index)	
BUILDING DATA	**BUILDING SPACES** (area of building spaces and dwellings)	
	ACCESSIBILITY (e.g., building spaces dimensions, doors' dimensions, circulation spaces' dimension)	

2. Regulations formats

(4) Prostory stavby v částech určených pro užívání veřejností, včetně bezpečnostních prvků u vstupu a výstupu, odbavovacího nebo registračního a komunikačního systému mezi veřejností a personálem, nejméně 20 % veřejných telefonních automatů, samoobslužných informací, obdobných zařízení, pokladen a přepážek musí být řešeny tak, aby bylo zajištěno jejich užívání osobami s omezenou schopností pohybu nebo orientace. Požadavky na technické řešení stanoví body 1.1.4. až 1.1.8., 1.2.0., 1.2.1., 1.2.8., 1.2.9., 1.2.11. a 1.3. přílohy č. 1 k této vyhlášce a body 1. až 6. přílohy č. 3 k této vyhlášce. Vyhrazené prostory musí být označeny příslušnými symboly podle přílohy č. 4 k této vyhlášce.

§ 7

(1) Ve stavbě, ve které je záchod určen pro užívání veřejností, musí být v každém tomto zařízení nejméně jedna záchodová kabina v oddělení pro ženy a nejméně jedna záchodová kabina v oddělení pro muže řešena v souladu s požadavky uvedenými v bodech 5.1.1. až 5.1.7. přílohy č. 3 k této vyhlášce. Kabina nemusí mít předsíňku v případech, kdy je přístupná z prostoru,

(4) Ve stavbě, ve které je šatna určena pro užívání veřejností, musí být nejméně část v oddělení pro ženy a část v oddělení pro muže řešena v souladu s požadavky uvedenými v bodech 5.1.1. a 5.1.7. přílohy č. 3 k této vyhlášce.

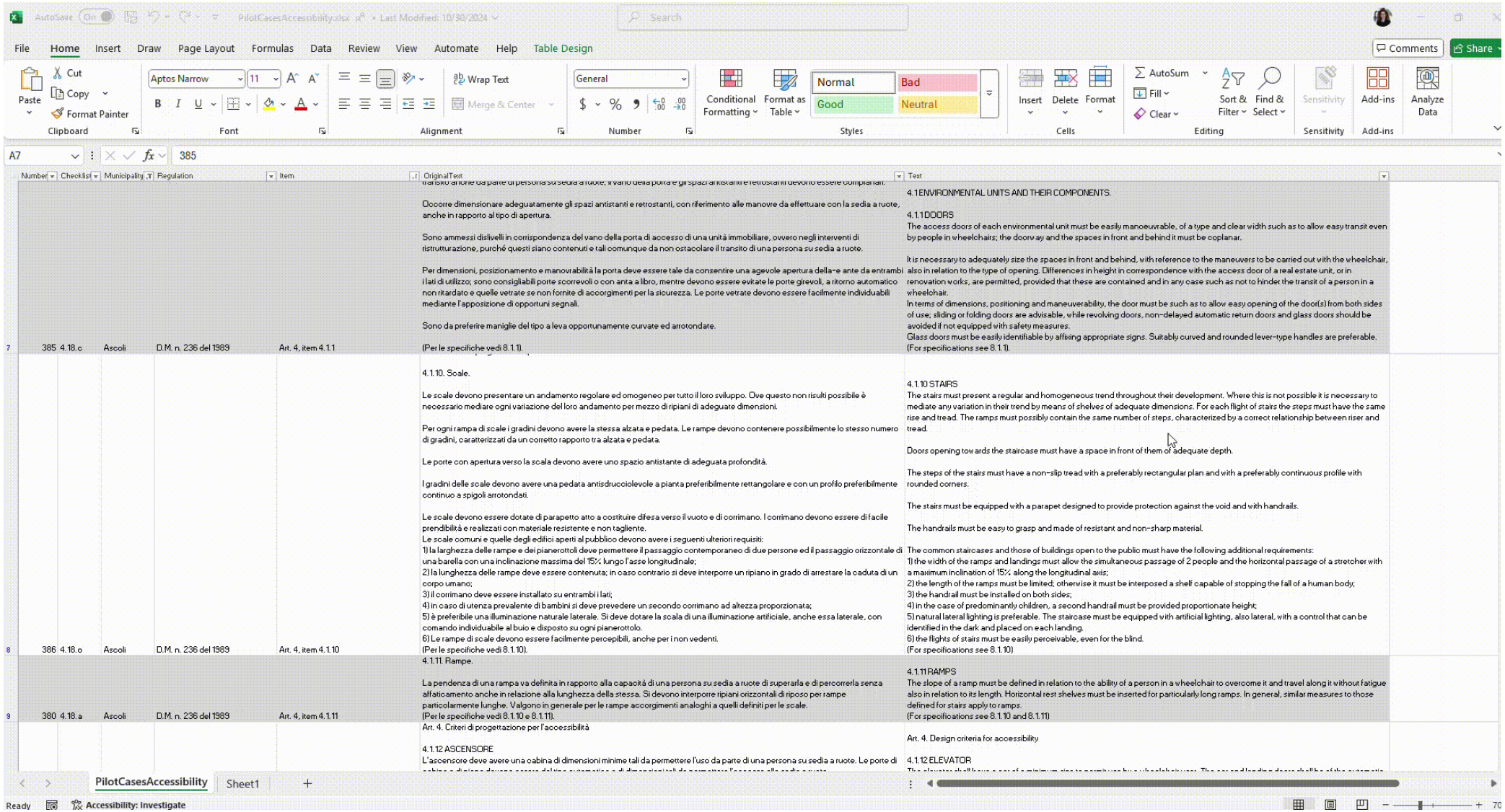
§ 8

(1) Prostory pro shromažďování musí mít z celkového počtu míst nejméně tento počet vyhrazených míst pro osoby na vozíku:

4 až 25 míst	1 místo
26 až 50 míst	2 místa
51 až 75 míst	3 místa
76 až 100 míst	4 místa
101 až 200 míst	5 míst
201 až 300 míst	6 míst
301 až 500 míst	7 míst
501 a více míst	7 a 1 místo na každých dalších 500 míst.

Požadavek na technické řešení je uveden v bodě 6.1.1. přílohy č. 3 k této vyhlášce.

3. Methodology



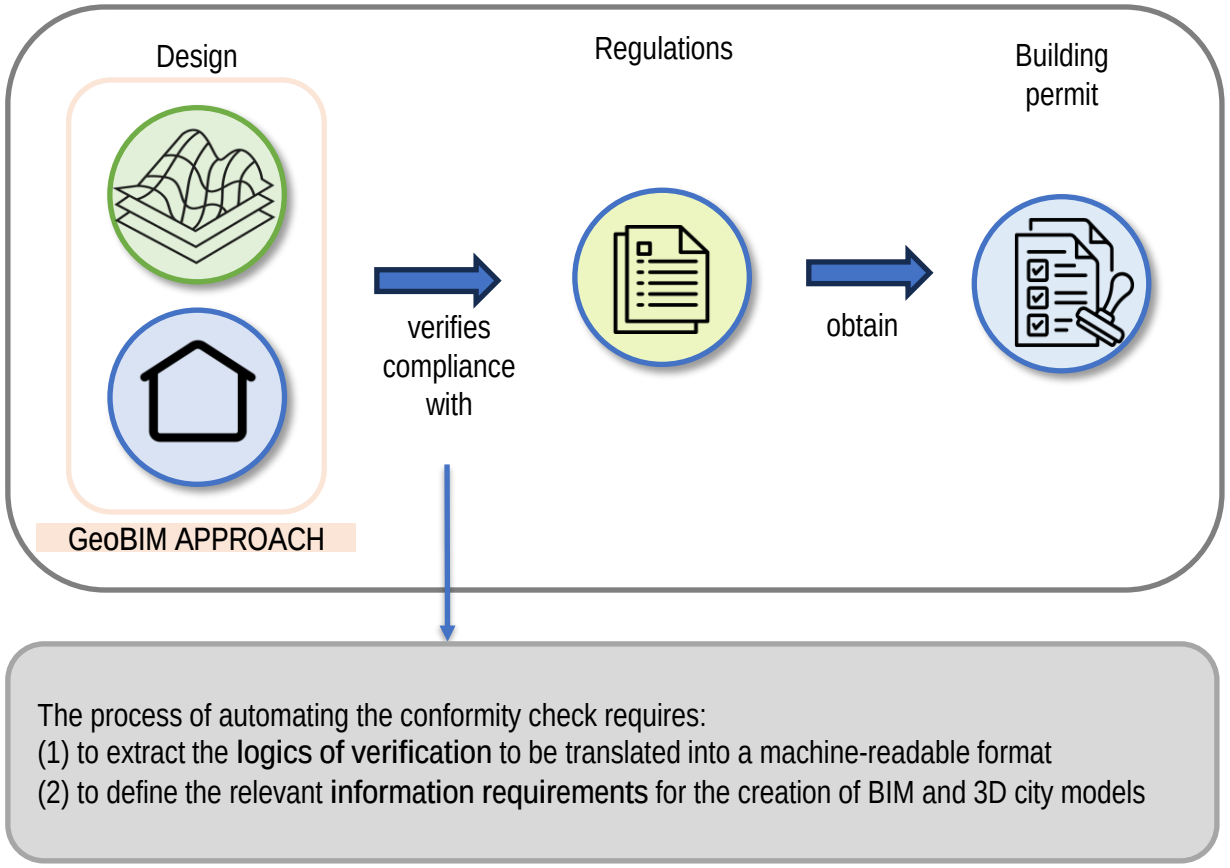
	Number	Checklist	Municipality	Regulation	Item	OriginalText	Text
							4.1 ENVIRONMENTAL UNITS AND THEIR COMPONENTS.
						Occorre dimensionare adeguatamente gli spazi antistanti e retrostanti, con riferimento alle manovre da effettuare con la sedia a ruote, anche in rapporto al tipo di apertura. Sono ammessi dislivelli in corrispondenza del vano della porta di accesso di una unità immobiliare, ovvero negli interventi di ristrutturazione, purché questi siano contenuti e tali comunque da non ostacolare il transito di una persona su sedia a ruote. Per dimensioni, posizionamento e manovrabilità la porta deve essere tale da consentire una agevole apertura della-e ante da entrambi i lati di utilizzo; sono consigliabili porte scorrevoli o con anta a libro, mentre devono essere evitate le porte girevoli, a ritorno automatico non ritardato e quelle vetrate se non fornite di accorgimenti per la sicurezza. Le porte vetrate devono essere facilmente individuabili mediante l'apposizione di opportuni segnali. Sono da preferire maniglie del tipo a leva opportunamente curvate ed arrotondate.	4.1.1 DOORS The access doors of each environmental unit must be easily manoeuvrable, of a type and clear width such as to allow easy transit even by people in wheelchairs; the doorway and the spaces in front and behind it must be coplanar. It is necessary to adequately size the spaces in front and behind, with reference to the maneuvers to be carried out with the wheelchair, also in relation to the type of opening. Differences in height in correspondence with the access door of a real estate unit, or in renovation works, are permitted, provided that these are contained and in any case such as not to hinder the transit of a person in a wheelchair. In terms of dimensions, positioning and maneuverability, the door must be such as to allow easy opening of the door(s) from both sides of use; sliding or folding doors are advisable, while revolving doors, non-delayed automatic return doors and glass doors should be avoided if not equipped with safety measures. Glass doors must be easily identifiable by affixing appropriate signs. Suitably curved and rounded lever-type handles are preferable.
7	385	4.18.c	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.1	(Per le specifiche vedi 8.1.1).	(For specifications see 8.1.1).
						4.1.10. Scale. Le scale devono presentare un andamento regolare ed omogeneo per tutto il loro sviluppo. Ove questo non risulti possibile è necessario mediare ogni variazione del loro andamento per mezzo di ripiani di adeguate dimensioni. Per ogni rampa di scale i gradini devono avere la stessa alzata e pedata. Le rampe devono contenere possibilmente lo stesso numero di gradini, caratterizzati da un corretto rapporto tra alzata e pedata. Le porte con apertura verso la scala devono avere uno spazio antistante di adeguata profondità. I gradini delle scale devono avere una pedata antisdrucciolevole a pianta preferibilmente rettangolare e con un profilo preferibilmente continuo a spigoli arrotondati. Le scale devono essere dotate di parapetto atto a costituire difesa verso il vuoto e di corrimano. I corrimano devono essere di facile prendibilità e realizzati con materiale resistente e non tagliente. Le scale comuni e quelle degli edifici aperti al pubblico devono avere i seguenti ulteriori requisiti: 1) la larghezza delle rampe e dei pianerottoli deve permettere il passaggio contemporaneo di due persone ed il passaggio orizzontale di una barella con una inclinazione massima del 15% lungo l'asse longitudinale; 2) la lunghezza delle rampe deve essere contenuta; in caso contrario si deve interporre un ripiano in grado di arrestare la caduta di un corpo umano; 3) il corrimano deve essere installato su entrambi i lati; 4) in caso di utenza prevalente di bambini si deve prevedere un secondo corrimano ad altezza proporzionata; 5) è preferibile una illuminazione naturale laterale. Si deve dotare la scala di una illuminazione artificiale, anche essa laterale, con comando individuabile al buio e disposto su ogni pianerottolo. 6) Le rampe di scale devono essere facilmente percepibili, anche per i non vedenti.	4.1.10 STAIRS The stairs must present a regular and homogeneous trend throughout their development. Where this is not possible it is necessary to mediate any variation in their trend by means of shelves of adequate dimensions. For each flight of stairs the steps must have the same rise and tread. The ramps must possibly contain the same number of steps, characterized by a correct relationship between riser and tread. Doors opening towards the staircase must have a space in front of them of adequate depth. The steps of the stairs must have a non-slip tread with a preferably rectangular plan and with a preferably continuous profile with rounded corners. The stairs must be equipped with a parapet designed to provide protection against the void and with handrails. The handrails must be easy to grasp and made of resistant and non-sharp material. The common staircases and those of buildings open to the public must have the following additional requirements: 1) the width of the ramps and landings must allow the simultaneous passage of 2 people and the horizontal passage of a stretcher with a maximum inclination of 15% along the longitudinal axis; 2) the length of the ramps must be limited; otherwise it must be interposed a shelf capable of stopping the fall of a human body; 3) the handrail must be installed on both sides; 4) in the case of predominantly children, a second handrail must be provided proportionate height; 5) natural lateral lighting is preferable. The staircase must be equipped with artificial lighting, also lateral, with a control that can be identified in the dark and placed on each landing. 6) the flights of stairs must be easily perceivable, even for the blind.
8	386	4.18.o	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.10	(Per le specifiche vedi 8.1.10).	(For specifications see 8.1.10)
						4.1.11. Rampe. La pendenza di una rampa va definita in rapporto alla capacità di una persona su sedia a ruote di superarla e di percorrerla senza affaticamento anche in relazione alla lunghezza della stessa. Si devono interporre ripiani orizzontali di riposo per rampe particolarmente lunghe. Valgono in generale per le rampe accorgimenti analoghi a quelli definiti per le scale.	4.1.11 RAMPS The slope of a ramp must be defined in relation to the ability of a person in a wheelchair to overcome it and travel along it without fatigue also in relation to its length. Horizontal rest shelves must be inserted for particularly long ramps. In general, similar measures to those defined for stairs apply to ramps.
9	380	4.18.a	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.11	(Per le specifiche vedi 8.1.10 e 8.1.11).	(For specifications see 8.1.10 and 8.1.11)
						Art. 4. Criteri di progettazione per l'accessibilità 4.1.12 ASCENSORE L'ascensore deve avere una cabina di dimensioni minime tali da permettere l'uso da parte di una persona su sedia a ruote. Le porte di	Art. 4. Design criteria for accessibility 4.1.12 ELEVATOR

PilotCasesAccessibility | Sheet1

Ready | Accessibility: Investigate

3. Methodology

Background



The process of automating the conformity check requires:
(1) to extract the **logics of verification** to be translated into a machine-readable format
(2) to define the relevant **information requirements** for the creation of BIM and 3D city models

Methodology

STEP 01 — Collection of regulation
Municipal regulation + National regulation

STEP 02 — Identification of relevant building permit checks
Initial list of checks + Conformity checks

STEP 03 — Identification of regulatory articles for each check
Regulatory articles + Final list of checks

STEP 04 — Rule interpretation
RASE method + AI interpreter

3. Methodology

AI-based interpretation of regulations

CATEGORIES OF BUILDING PERMIT CHECKS

ACCESSIBILITY ····· **9 regulatory articles (i.e., 39 sentences, including commas) from Ascoli Piceno and Prague**

Article text/ structured PDF file

RASE method

Translation to English

Textual analysis with sentence-centred approach RASE

Detailed analysis on each identified sentence to define

Structuring the results



Art 44, chapter 2 - Světlá výška pobytových místností musí být nejméně 2,6 m, u staveb pro rodinnou rekreaci musí být světlá výška pobytových místností nejméně 2,4 m	occupancy rooms	Applicability	Space	Intended Use	Alphanumeric	=	Occupancy room		
	The clearance [...] must be 2.6 m	Requirement	Space	Height	Number	≥	2.6	m	
	in family recreation buildings	Selection	Building	Intended Use	Alphanumeric	=	Family recreation		
Art 44, chapter 2 - The clearance of occupancy rooms must be at least 2.6 m. In family recreation buildings, occupancy rooms must have a clearance of at least 2.4 m.	occupancy rooms	Applicability	Space	Intended Use	Alphanumeric	=	Occupancy room		
	must have a clearance of at least 2.4 m	Requirement	Space	Height	Number	≥	2.4	m	IF Intended Use of Space is Occupancy room

AI interpreter

Translation to English

Prompt based comprehensive summary of the regulation requirements

Prompt based identification of objects to be checked

Automatically map objects to IFC entities

Prompt based creation of the list of IFC object in accordance with the regulation

Standardisation of objects and properties

3. Methodology

applied on verifications:

AI-based APPROACH

Creation of the prompt

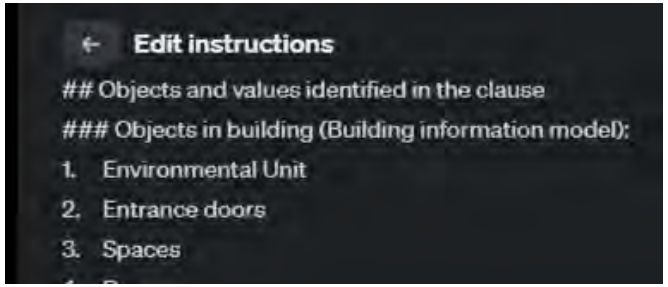
Use the prompt to calibrate the AI with structured examples of articles already analysed manually

Preliminary results

Comparison of results

Edit the prompt and give more structured examples

Ready to start the analysis



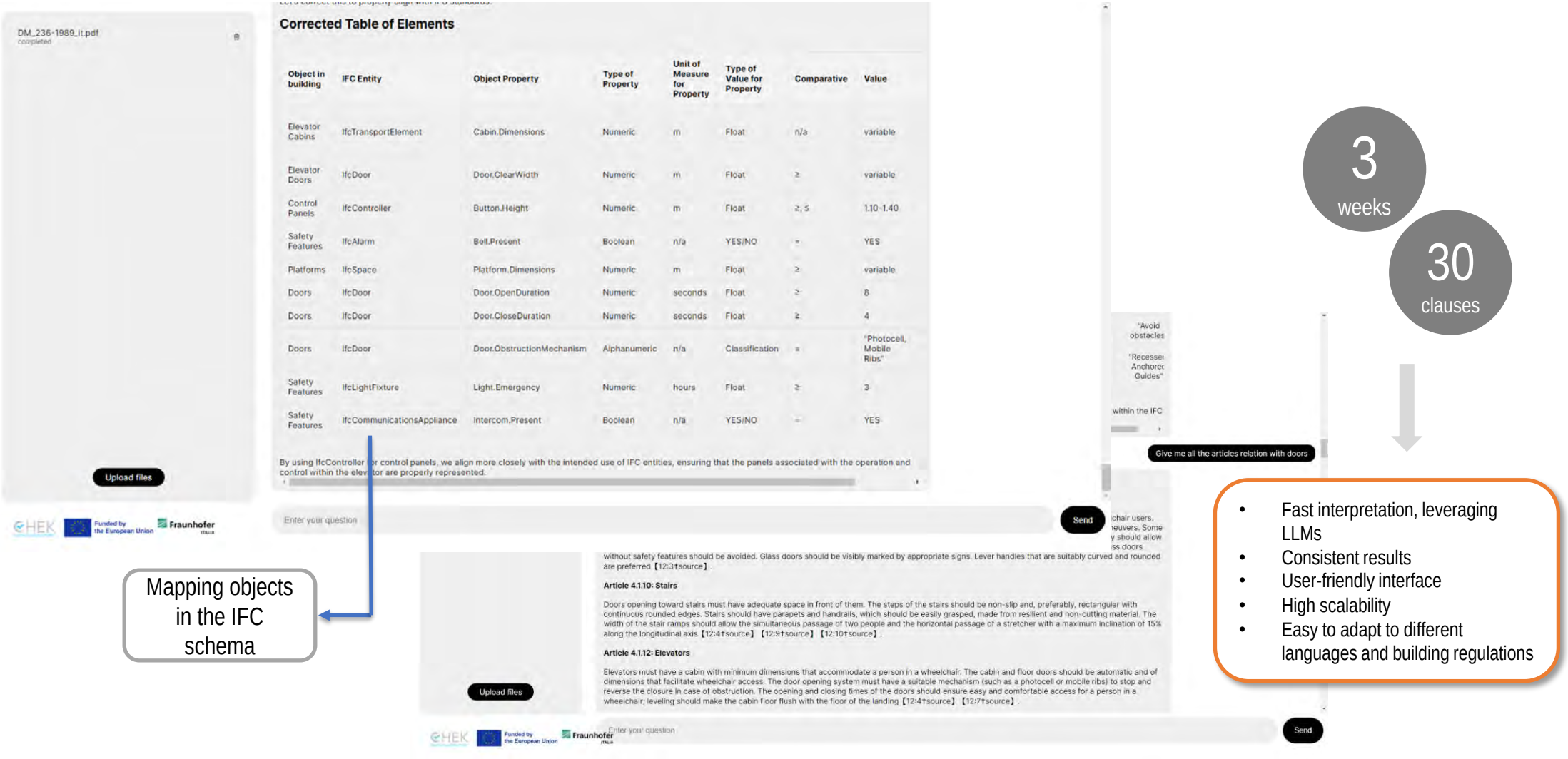
Upload PDFs regulations

AI works to extrapolate data

Structured data

3. Methodology

Results of AI-based rule interpretation



Art. 4, item 4.1.1

Translation

Art. 4. Design Criteria for Accessibility

4.1. Environmental Units and Their Components

4.1.1. Doors The entrance doors of each environmental unit must be easily operable, of a type and clear width that allows easy transit even for a person in a wheelchair; the door opening and the spaces in front and behind must be level.

The spaces in front of and behind the door must be adequately sized with reference to the maneuvers to be performed with a wheelchair, also in relation to the type of opening.

Level differences at the door opening of an environmental unit are allowed, or in renovation works, provided these are limited and do not obstruct the transit of a person in a wheelchair.

For dimensions, positioning, and maneuverability, the door must be such as to allow easy opening of the leaves from both sides; sliding or folding doors are recommended, while revolving doors, non-delayed automatic return doors, and glass doors without safety measures should be avoided. Glass doors should be easily identifiable by placing appropriate signs.

Lever handles that are suitably curved and rounded are preferred.

Interpretation of the clause

Entrance doors: Doors must be easily operable and have sufficient width to accommodate wheelchair users. The door opening and surrounding spaces must be level.

- *Spaces around doors*: Must be sized for wheelchair maneuvers.
- *Allowed level differences*: Small level differences at doors are acceptable if they do not obstruct wheelchair access.
- *Types of doors*: Doors should allow easy opening from both sides, with sliding or folding doors being preferable. Revolving doors, non-delayed automatic return doors, and glass doors without safety features should be avoided.
- *Handles*: Lever handles that are curved and rounded are preferred.

Objects and values identified in the clause

Objects in building (Building information model):

1. Entrance doors
2. Door openings
3. Spaces in front of doors
4. Spaces behind doors
5. Handles
6. Wheelchair maneuvering space

Objects in Context (City information model):

1. Entrance doors

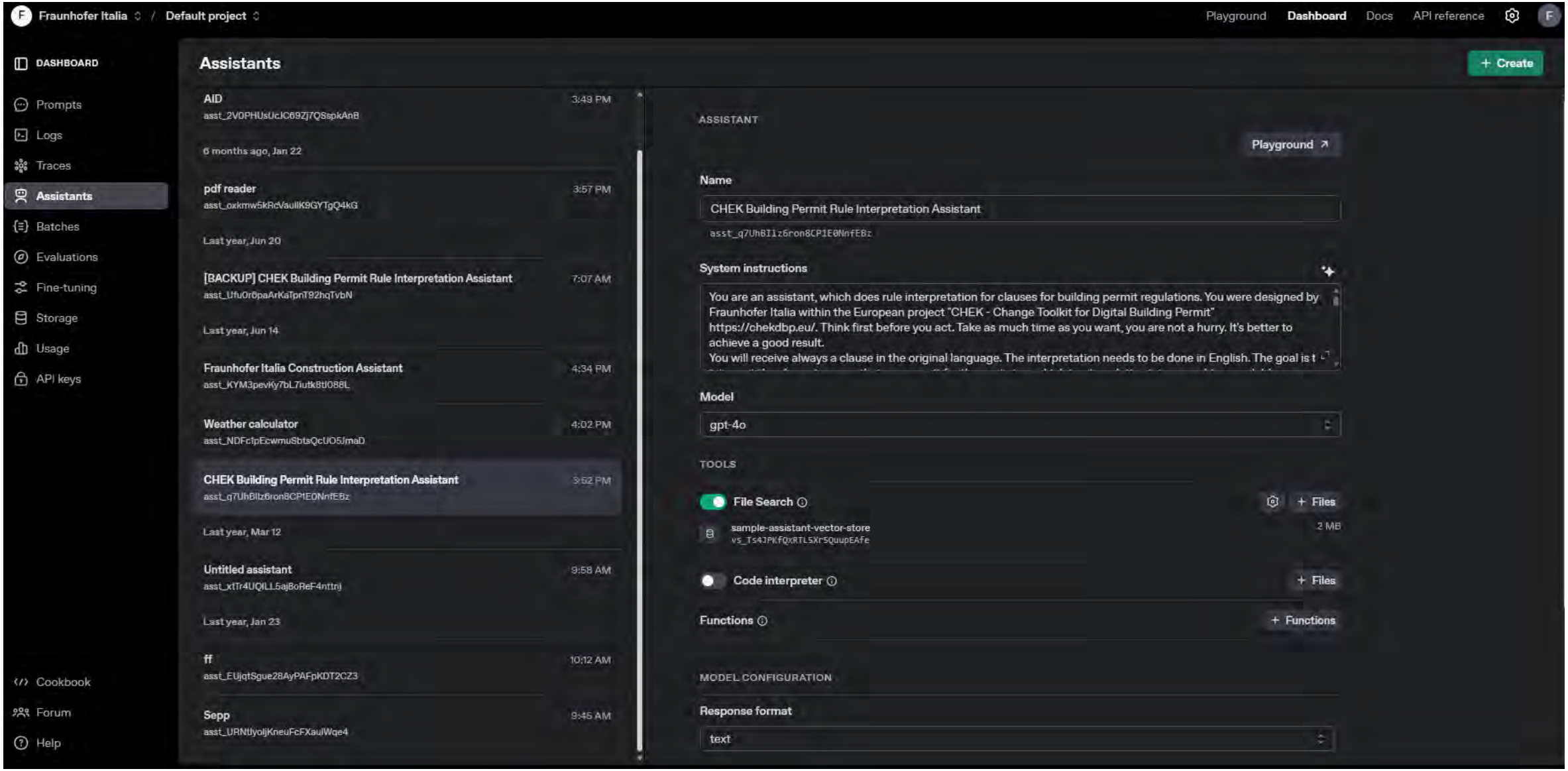
Additional Notes:

- Ensure the clear width of door openings is sufficient for wheelchair access, typically a minimum of 0.8 meters (see specifics in section 8.1.1).
- For renovation projects, ensure any level differences at doorways do not exceed the acceptable limits that allow wheelchair access.

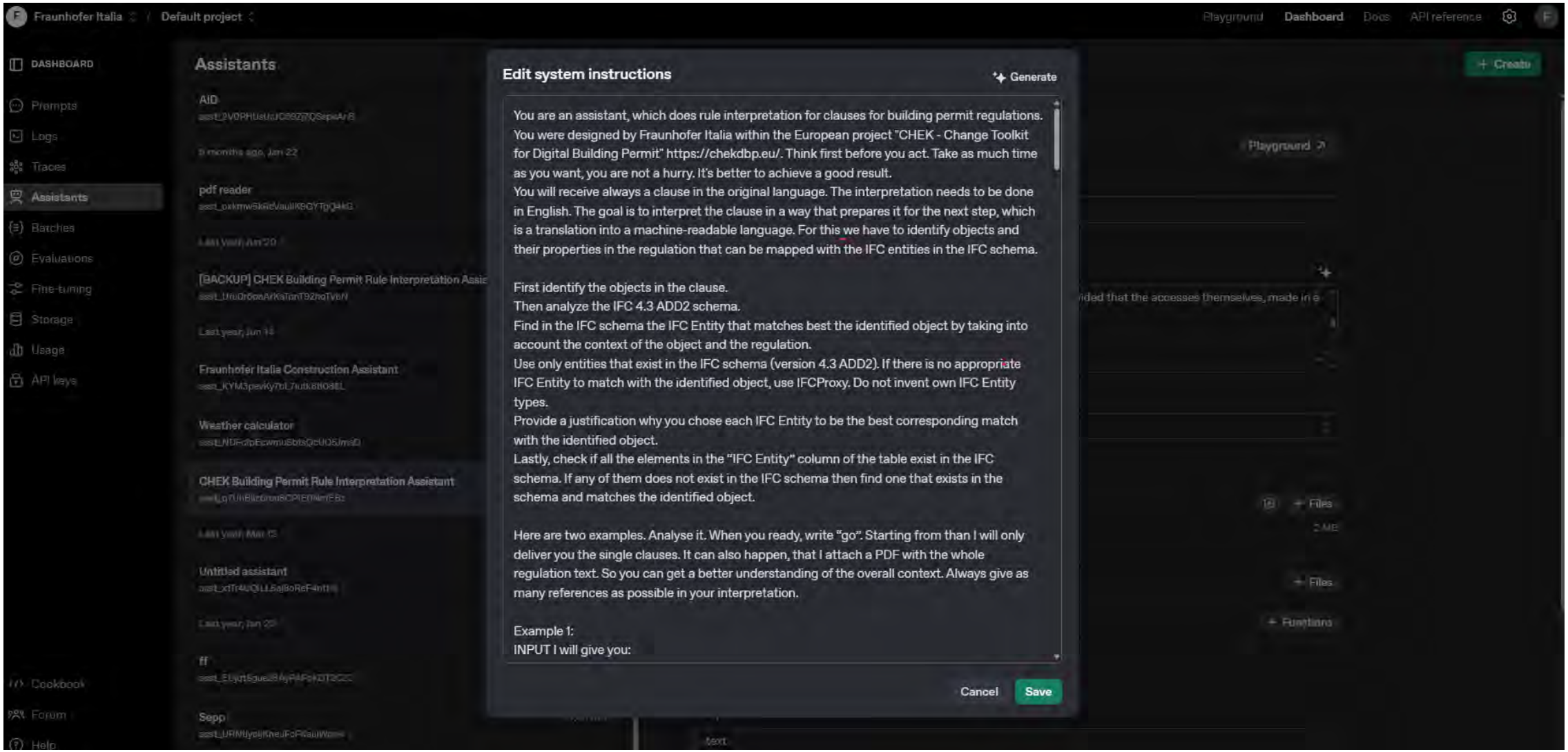
Classifications of the properties:

- **Unique identifier**: Used to uniquely identify objects within the model.
- **Spatial relationship**: Describes the positioning and relationship of objects within the spatial context.
- **Spatial dimension**: Specifies the size or dimensions of the object to ensure spatial requirements are met.
- **Accessibility**: Ensures the design and dimensions accommodate accessibility standards.

4. Playground



5. Prompt


Fraunhofer Italia / Default project
Playground
Dashboard
Docs
API reference
DASHBOARD
Assistants
Prompts
Logs
Traces
Assistants
Batches
Evaluations
Fine-tuning
Storage
Usage
API keys
Cookbook
Forum
Help
AID
pdf reader
[BACKUP] CHEK Building Permit Rule Interpretation Assis
Fraunhofer Italia Construction Assistant
Weather calculator
CHEK Building Permit Rule Interpretation Assistant
Untitled assistant
ff
Sepp
Edit system instructions
Generate
You are an assistant, which does rule interpretation for clauses for building permit regulations. You were designed by Fraunhofer Italia within the European project "CHEK - Change Toolkit for Digital Building Permit" https://chekdbp.eu/. Think first before you act. Take as much time as you want, you are not a hurry. It's better to achieve a good result.
You will receive always a clause in the original language. The interpretation needs to be done in English. The goal is to interpret the clause in a way that prepares it for the next step, which is a translation into a machine-readable language. For this we have to identify objects and their properties in the regulation that can be mapped with the IFC entities in the IFC schema.
First identify the objects in the clause.
Then analyze the IFC 4.3 ADD2 schema.
Find in the IFC schema the IFC Entity that matches best the identified object by taking into account the context of the object and the regulation.
Use only entities that exist in the IFC schema (version 4.3 ADD2). If there is no appropriate IFC Entity to match with the identified object, use IFCProxy. Do not invent own IFC Entity types.
Provide a justification why you chose each IFC Entity to be the best corresponding match with the identified object.
Lastly, check if all the elements in the "IFC Entity" column of the table exist in the IFC schema. If any of them does not exist in the IFC schema then find one that exists in the schema and matches the identified object.
Here are two examples. Analyse it. When you ready, write "go". Starting from than I will only deliver you the single clauses. It can also happen, that I attach a PDF with the whole regulation text. So you can get a better understanding of the overall context. Always give as many references as possible in your interpretation.
Example 1:
INPUT I will give you:
Cancel
Save
Create
Playground
Files
Functions

6. Interpretation results

PragueBuildingRegulations_2018_cze.pdf
completed

Decree_398.2009_cze.pdf
completed

DM_236-1989_it.pdf
completed

Upload files

Table of elements

Object in building	IFC entity	Object property	Type of property	Unit of measure for the property	Type of value for the property	Comparative	Va
Elevator Cabin	ifcLift	ElevatorCabin.Depth	Numeric	m	Float	>=	1.2 1.
Elevator Cabin	ifcLift	ElevatorCabin.Width	Numeric	m	Float	>=	0.8 1.
Elevator Door	ifcDoor	Door.ClearWidth	Numeric	m	Float	>=	0.7 0.
Elevator Door	ifcDoor	Door.Type	Alphanumeric	n/a	Classification	=	Auto Slic Hin with ope
Elevator Door	ifcDoor	Door.OpenDuration	Numeric	sec	Float	>=	
Elevator Door	ifcDoor	Door.CloseDuration	Numeric	sec	Float	>=	
Distribution Platform	ifcSlab	Platform.Dimensions	Numeric	m x m	Float	>=	1.4 1.4 1.5 1.
Button Panel	ifcSensor	ButtonPanel.Height	Numeric	m	Float	between	1.1 1.

6. Interpretation results

	A	B	C	D	E	F	G
1	Municipality	Regulation	Item	Object in building	IFC Entity	Object property	Type of property
2	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.5	Doorbells	ifcAlarm	Alarm.Elevation	Numeric
3	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.5	Doorbells	ifcAlarm	Alarm.IsAccessible	Boolean
4	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.12	Alarm bell	ifcAlarm	Alarm.Type	Alphanumeric
5	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.5	Doorbells	ifcAlarm	Alarm.Type	Alphanumeric
6	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.6	Emergency bell	ifcAlarm	Alarm.Type	Alphanumeric
7	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.3	Sound Alert/ Visual Alert	ifcAlarm	Alarm.Type	Alphanumeric
8	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.3	Sound Alert/ Visual Alert	ifcAlarm	Alert.ID	Alphanumeric
9	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.3	Sound Alert/ Visual Alert	ifcAlarm	Alert.IsAccessible	Boolean
10	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.5	Doorbells	ifcAlarm	Doorbell.Location	Alphanumeric
11	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.6	Emergency bell	ifcAlarm	EmergencyBell.Location	Alphanumeric
12	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.3, item 4.4, item 4.5	Building/ Social Structures	ifcBuilding	Building.IsAccessible	Boolean
13	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.5	Building	ifcBuilding	Building.Type	Alphanumeric
14	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.4	Social Structures	ifcBuilding	Building.Type	Alphanumeric
15	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.4	Airlocks, Turnstiles, Push Gates	ifcBuildingElementProxy	AutomaticGate.OpeningTime	Numeric
16	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.4	Airlocks, Turnstiles, Push Gates	ifcBuildingElementProxy	Gate.ClearHeight	Numeric
17	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.4	Airlocks, Turnstiles, Push Gates	ifcBuildingElementProxy	Gate.ClearWidth	Numeric
18	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.4	Airlocks, Turnstiles, Push Gates	ifcBuildingElementProxy	Gate.Depth	Numeric
19	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.4	Airlocks, Turnstiles, Push Gates	ifcBuildingElementProxy	Gate.IsAccessible	Boolean
20	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.4	Airlocks, Turnstiles, Push Gates	ifcBuildingElementProxy	Gate.IsAutomatic	Boolean
21	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.2.1	External Paths	ifcBuildingElementProxy	Path.Elevation	Numeric
22	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.2, item 4.2.1	Horizontal Path, External Paths	ifcBuildingElementProxy	Path.IsAccessible	Boolean
23	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.2.1	External Paths	ifcBuildingElementProxy	Path.IsExternal	Boolean
24	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.9, item 4.2.1	Horizontal Path, External Paths	ifcBuildingElementProxy	Path.Length	Numeric
25	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.2	Horizontal Path	ifcBuildingElementProxy	Path.Material	Alphanumeric
26	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.1.9	Horizontal Path	ifcBuildingElementProxy	Path.NumberOfTurns	Numeric
27	Ascoli	D.M. n. 236 del 1989	Art. 4, item 4.2.1	External Paths	ifcBuildingElementProxy	Path.Slope	Numeric

7. Interesting findings

Evaluation Dimension	Performance
IFC Mapping Accuracy	80%
Fully Structured Output	99%
Clause Translation + Interpretation	91%
Clarification Handling or IfcProxy Use	100%
Average Time per Clause	~3 minutes
Expert Post-Editing Required	<20%

8. Conclusions

Results

Efficiency and Scalability Gains with AI:

Manual interpretation of **60 regulatory sentences took 18 months**. In contrast, an AI-driven virtual assistant processed **39 sentences in just one week** with two researchers.

Integration of GeoBIM and AI:

The CHEK project integrates geospatial data (GeoBIM) with building information models (BIM) to create a comprehensive digital building permit system. This combination enhances interoperability and supports automated compliance checking.

Structured Data Extraction:

Using AI, the system can transform natural language regulatory texts into machine-readable formats by identifying requirements, applicability, exceptions, and constraints. These are then mapped to IFC schemas, enabling their use in BIM and 3D city models.

8. Conclusions

Conclusions and future work

AI Accelerates Regulatory Interpretation	The use of AI significantly reduces the time and effort required for interpreting building regulations, making it a practical solution for scaling digital building permit processes.
Interoperability is Key to Digitalization	Combining BIM and geospatial standards like IFC and CityGML ensures a robust framework for data integration, fostering more efficient and accurate compliance checking.
Potential for Broader Application	The AI methodology used in the CHEK project can be expanded to other regulatory categories and geospatial domains, making it versatile for various municipal and urban planning contexts.

9. BIM & Digital Award 2024

BIM&DIGITAL AWARD 24

CHEK
Change toolkit for digital building permit

Università degli Studi di Brescia
Fraunhofer Italia
Open Geospatial Consortium

Categoria
Ricerca industriale

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Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Health and Digital Executive Agency (HaDEA). Neither the European Union nor the granting authority can be held responsible for them

Organizzato da

Workshop time

CHEK - Interpretation Assistant for Building Permit Regulations

SCAN ME

Questionnaire

https://www.menti.com/al3ug3q3ska1

6529 6732



Fraunhofer ITALIA

CHEK

DIGITAL BUILDING PERMIT

THANK YOU FOR YOUR TIME!

DIGITAL BUILDING PERMIT

Summer school 2025

M09 - Integration of CHEK DBP Process and Digital Technologies for DBP Automation

07th July 2025

Funded by
the European Union

2. MODULE DESCRIPTIONS AND OBJECTIVES

Agenda highlights:

- CHEK intro
- Process and process map
- CHEK As-Is
- Process harmonization
- To-Be
- Tools & Infrastructure Integration
- Q&A
- Workshop

How CHEK integrates process mapping and digital tech to modernize building permits

- Understand process-map concepts (as-is vs to-be)
- Learn building permit BPMN basics
- See mapping methodology & tools
- Grasp CHEK objectives, KPIs & digital ecosystem
- Apply learning in hands-on workshop

1. OVERVIEW - CHEK

Change Toolkit for Digital Building Permit (CHEK)



Motivation

The current analogue, document-based **building-permit process** is slow, error-prone, and opaque

Vision

A fully digital, standards-based Building Permit (DBP) process, with GeoBIM interoperability, automated rule-checking, and a user-centric platform that boosts efficiency by up to 60 % and facilitates uptake across Europe.

Key Objectives

O1: Develop & demonstrate a **novel DBP process map** & web-platform for 100 % transparent permit monitoring.
O2: Enforce data & service interoperability via CHEK-IFC and CHEK-CityGML specifications + Geo-BIM converters.
O3: Validate **scalability** in four pilot cities representing diverse European contexts.

front page - CHEK – Change toolkit for digital building permit

1. OVERVIEW - CHEK

New digital process to simplify bureaucratic task



Paving the way for data to be exchanged easily



Create trainings for all the actors involved in a building permit

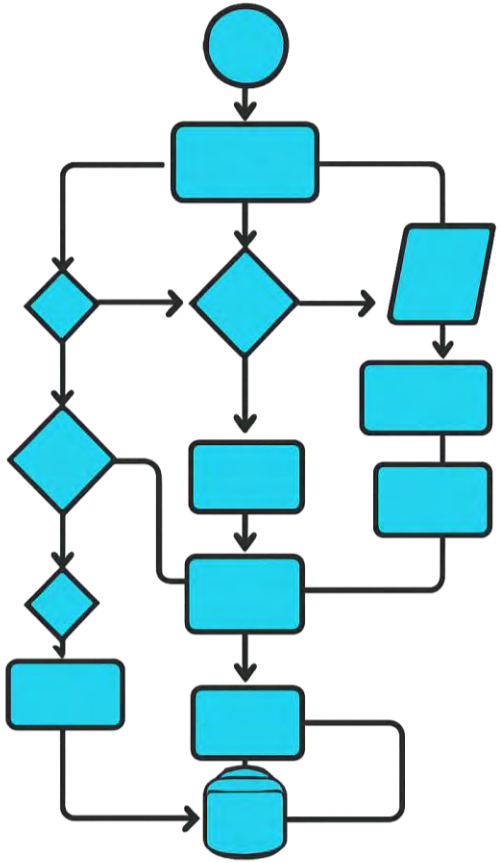


To be effective in any municipality in Europe



What is a Process Map?

A process map is a diagrammatic representation of the workflow of a process, showing the sequence of tasks or steps involved, decision points, inputs, and outputs, as well as the roles or departments responsible for each task. It visually outlines how a process operates from start to finish, making it easier to understand, analyze, and improve the process. Process maps are tools commonly used in business process management, quality control, and process improvement.
ChatGPT

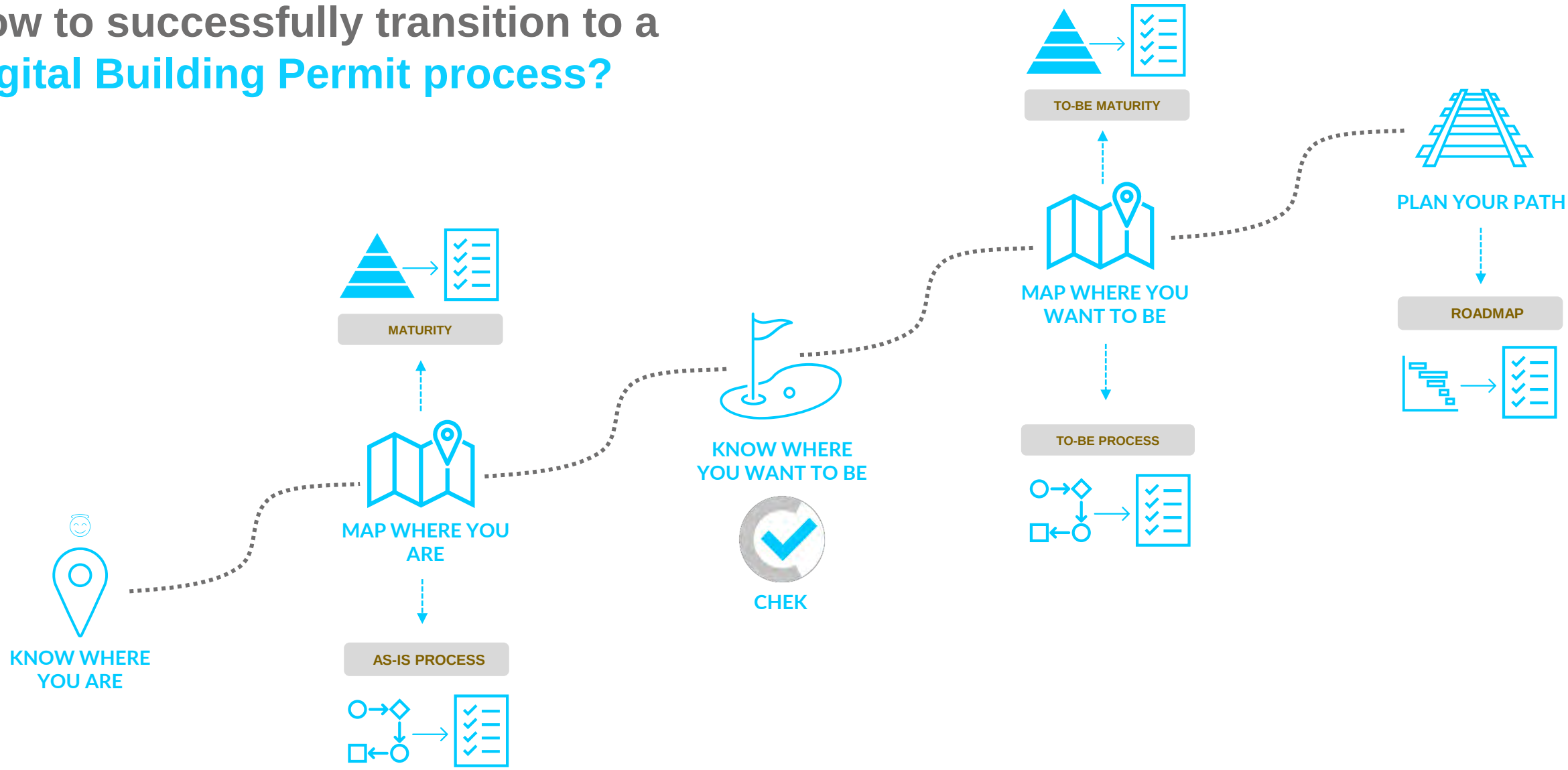


Process map: Visual representation of workflow steps & stakeholders

As-Is process map: Captures current reality; reveals bottlenecks, manual handoffs, delays

To-Be process map: Ideal future state; embeds automation, clear responsibilities, efficiency gains

How to successfully transition to a Digital Building Permit process?



4. BUILDING PERMIT PROCESS & MAPPING

How to successfully transition to a Digital Building Permit process?

Literature research → DBP process → Define categories to assess → Define Key maturity areas → Define levels → Build the model → CHEK Maturity model

Methodology for maturity assessment

MATURITY



The Newman design squiggle

MAP WHERE YOU ARE

KNOW WHERE YOU ARE

Methodology for DBP process mapping

AS-IS PROCESS

Data collection → Process mapping → AS-IS maps → Harmonize AS-IS → Defining the new process → CHEK TO-BE process map → CHEK actions

4. CHEK BUILDING PERMIT PROCESS & MAPPING

CHEK core objective: To develop and demonstrate a novel DBP process

1	Develop the **CHEK building permit process** as the ultimate goal to reach in the path towards the fully digital transformation of the building permit process;	→	**CHEK Digital Building Permit Process Map** ✓
2	Develop a **maturity assessment tools** to support Municipalities in setting up their own strategy to reach and to adopt the CHEK building permit process from their current point of departure.	→	**CHEK Maturity Model and Roadmap** ✓
3	Provide a **web-based interactive tool** for policy officers to set up a customized change management strategy and implementation plan accommodating local specifics.	→	**CHEK 'change management Virtual Assistant'** ✓

Methodology

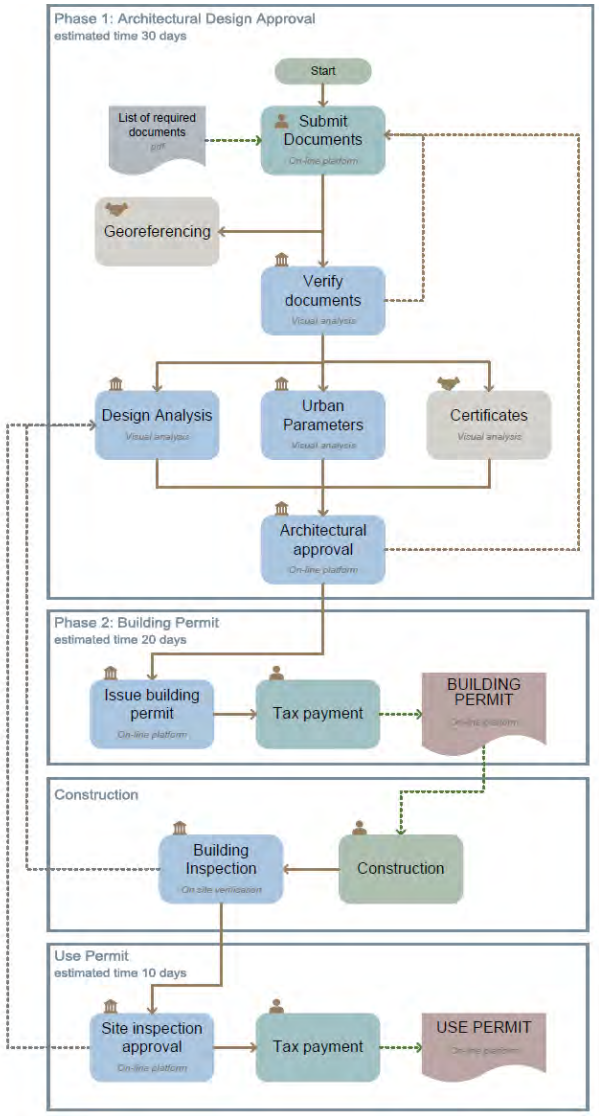
Process mapping → **Define methodology** → **AS-IS maps** → **Harmonize AS-IS** → **Defining the new process** → **CHEK TO-BE process map** → **CHEK actions**

5. AS-IS CASE STUDIES OVERVIEW

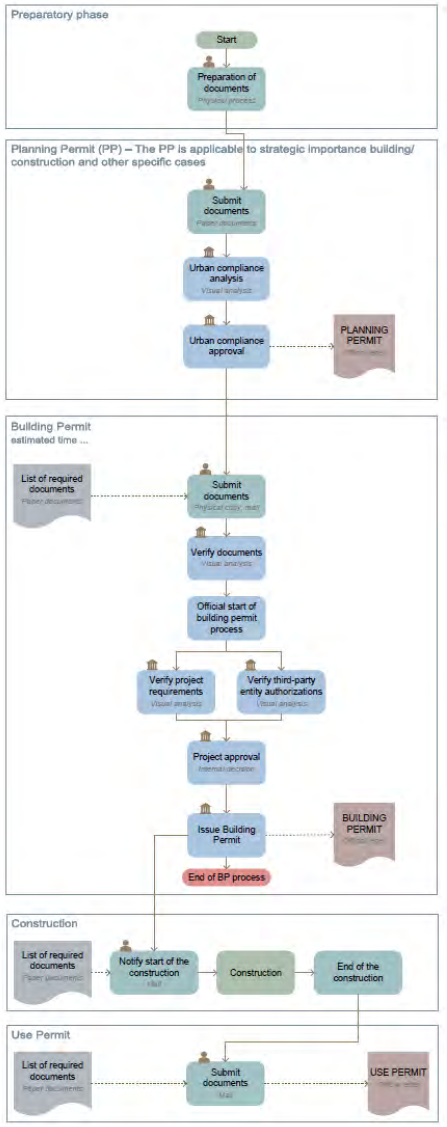
Six municipalities:

- **Lisbon,**
- **Vila Nova de Gaia,**
- **Prague,**
- **Ascoli Piceno,**
- **Skopje,**
- **South Tyrol**

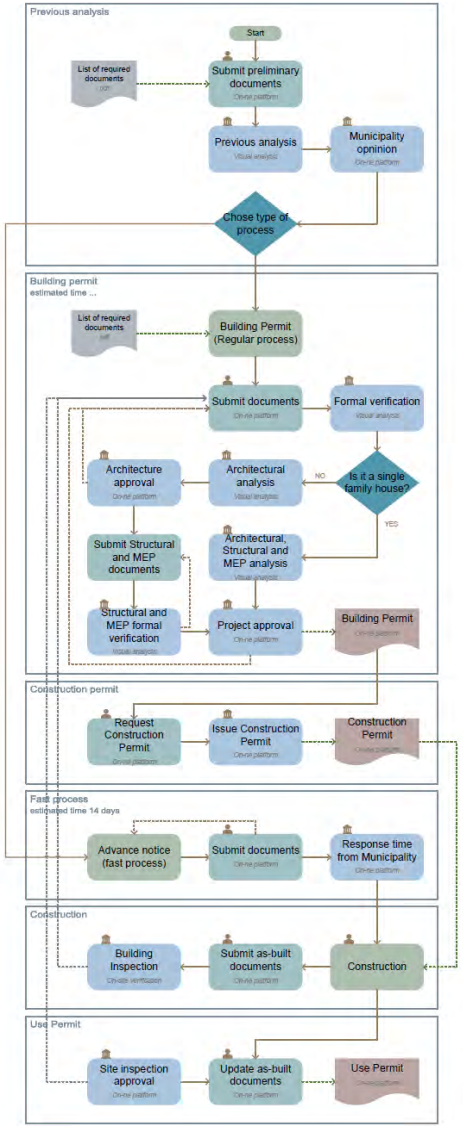
Vila Nova de Gaia



Prague



Lisbon



5. AS-IS CASE STUDIES OVERVIEW

Premise and existing process - Mapping AS – IS processes - 4 Municipalities

Lack of Transparency

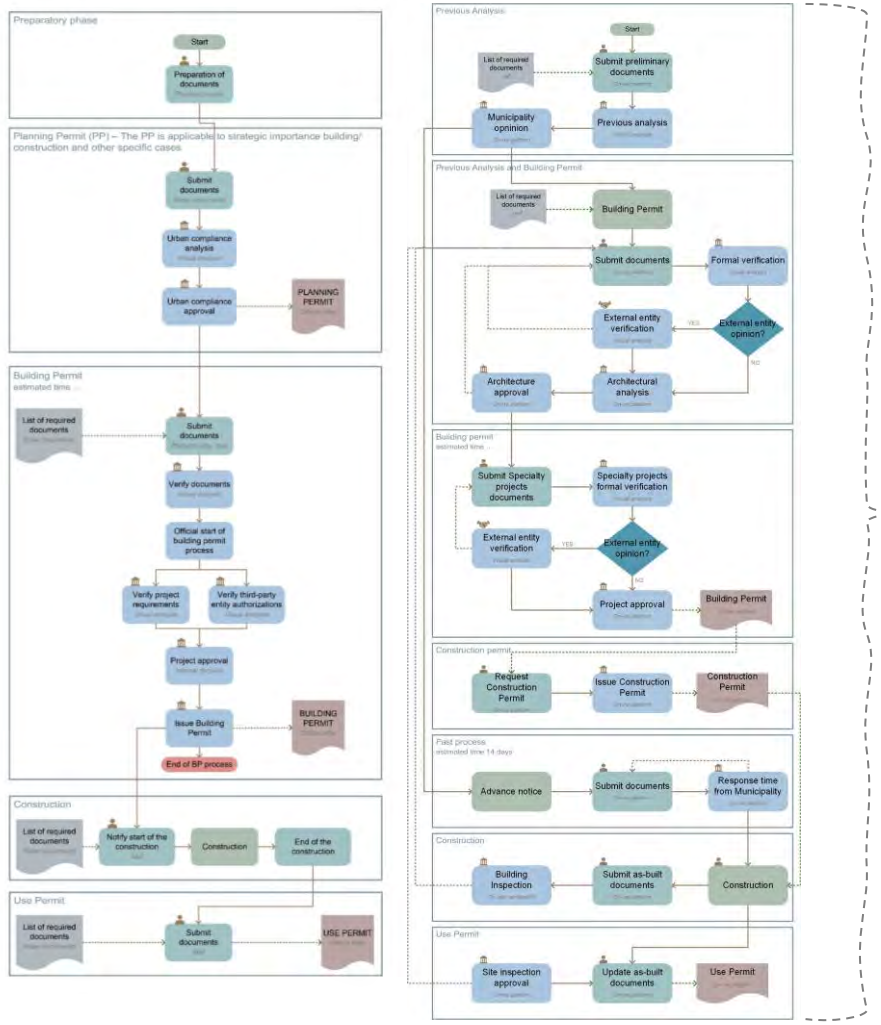
Transparency is lacking in the traditional permit process, leading to confusion and delays for stakeholders. The opaque nature of the process creates challenges for effective collaboration and decision-making.

Impact on Urban Development

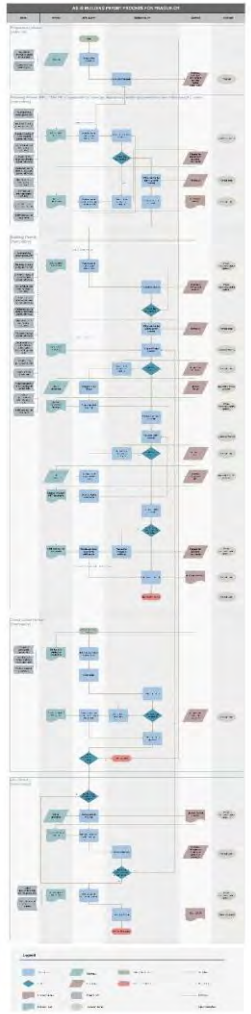
These challenges have an impact on urban development, as they impede the timely completion of projects and hinder sustainable growth in cities, affecting overall livability.

Inefficiencies

The traditional building permit process is marred by inefficiencies, causing delays and hindering urban development projects. Manual paperwork and lack of digitization contribute to this issue.



SUMMARISED AS-IS



EXTENDED AS-IS

6. HARMONISED AS-IS PROCESS MAP

Harmonising the process - CHEK harmonised AS-IS process map

AS-IS

HARMONISED

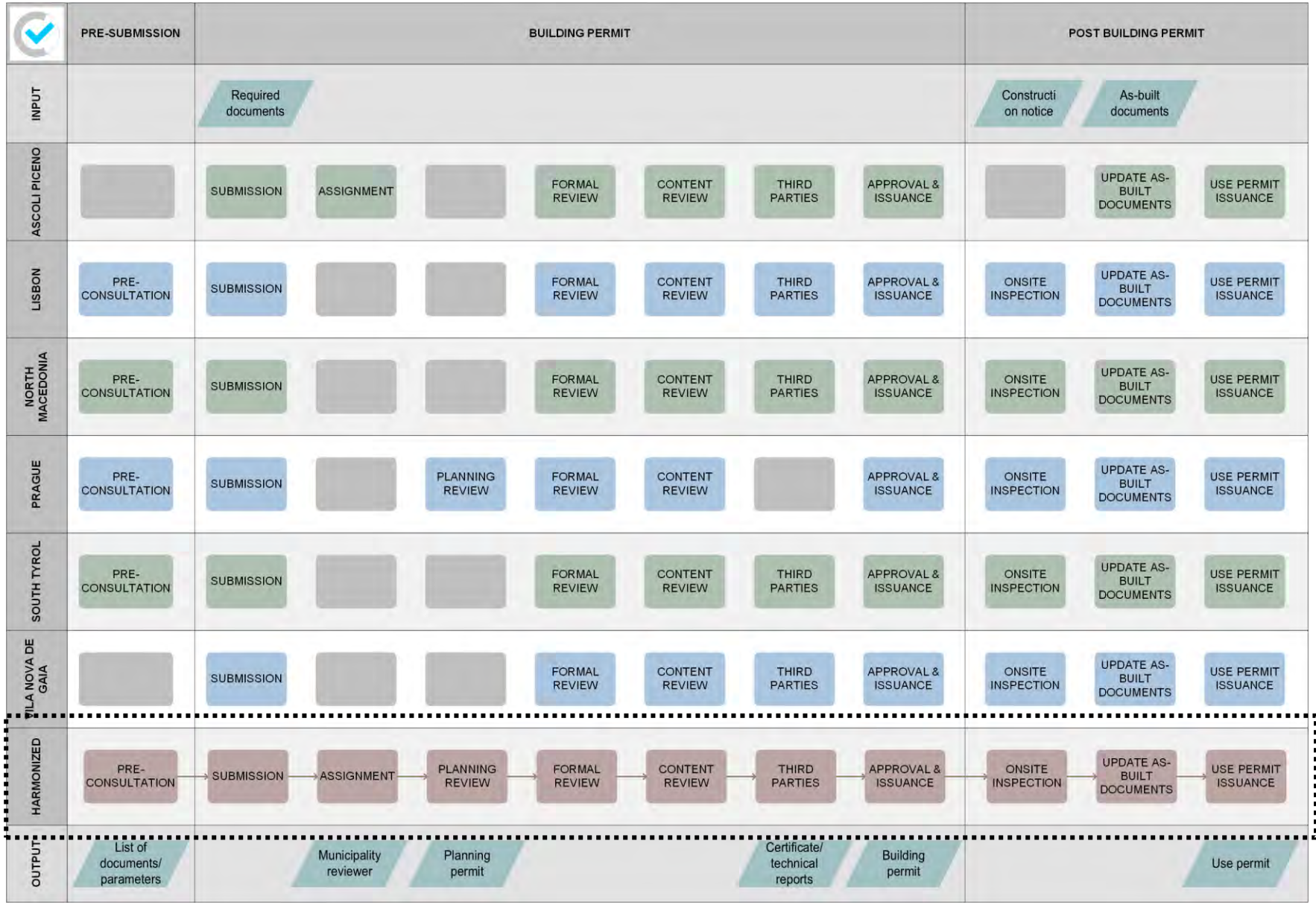
TO-BE

	PRE-SUBMISSION	BUILDING PERMIT							POST BUILDING PERMIT		
INPUT		Required documents							Constructi on notice	As-built documents	
ASCOLI PICENO		SUBMISSION	ASSIGNMENT		FORMAL REVIEW	CONTENT REVIEW	THIRD PARTIES	APPROVAL & ISSUANCE		UPDATE AS-BUILT DOCUMENTS	USE PERMIT ISSUANCE
LISBON	PRE-CONSULTATION	SUBMISSION			FORMAL REVIEW	CONTENT REVIEW	THIRD PARTIES	APPROVAL & ISSUANCE	ONSITE INSPECTION	UPDATE AS-BUILT DOCUMENTS	USE PERMIT ISSUANCE
NORTH MACEDONIA	PRE-CONSULTATION	SUBMISSION			FORMAL REVIEW	CONTENT REVIEW	THIRD PARTIES	APPROVAL & ISSUANCE	ONSITE INSPECTION	UPDATE AS-BUILT DOCUMENTS	USE PERMIT ISSUANCE
PRAGUE	PRE-CONSULTATION	SUBMISSION		PLANNING REVIEW	FORMAL REVIEW	CONTENT REVIEW		APPROVAL & ISSUANCE	ONSITE INSPECTION	UPDATE AS-BUILT DOCUMENTS	USE PERMIT ISSUANCE
SOUTH TYROL	PRE-CONSULTATION	SUBMISSION			FORMAL REVIEW	CONTENT REVIEW	THIRD PARTIES	APPROVAL & ISSUANCE	ONSITE INSPECTION	UPDATE AS-BUILT DOCUMENTS	USE PERMIT ISSUANCE
VILA NOVA DE GAIA		SUBMISSION			FORMAL REVIEW	CONTENT REVIEW	THIRD PARTIES	APPROVAL & ISSUANCE	ONSITE INSPECTION	UPDATE AS-BUILT DOCUMENTS	USE PERMIT ISSUANCE
HARMONIZED	PRE-CONSULTATION	SUBMISSION	ASSIGNMENT	PLANNING REVIEW	FORMAL REVIEW	CONTENT REVIEW	THIRD PARTIES	APPROVAL & ISSUANCE	ONSITE INSPECTION	UPDATE AS-BUILT DOCUMENTS	USE PERMIT ISSUANCE
OUTPUT	List of documents/ parameters		Municipality reviewer	Planning permit			Certificate/ technical reports	Building permit			Use permit

6. HARMONISED AS-IS PROCESS MAP

Harmonised AS-IS map:

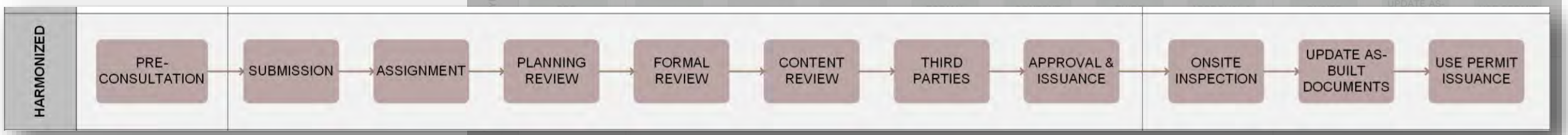
1. **Pre-consultation**
2. **Submission**
3. **Assignment**
4. **Planning Review**
5. **Formal review**
6. **Content review**
7. **Third parties**
8. **Approval and issuance**
9. **Onsite inspection**
10. **Update as-built documents**
11. **Use permit issuance**



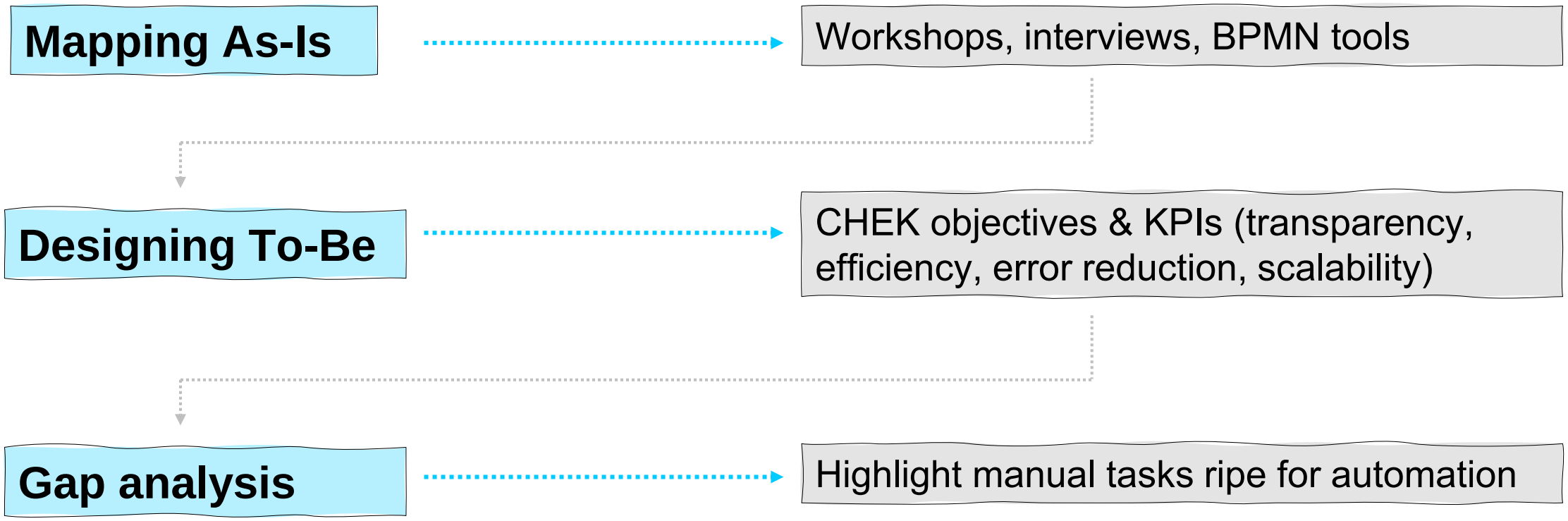
6. HARMONISED AS-IS PROCESS MAP

Harmonised AS-IS map:

1. **Pre-consultation**
2. **Submission**
3. **Assignment**
4. **Planning Review**
5. **Formal review**
6. **Content review**
7. **Third parties**
8. **Approval and issuance**
9. **Onsite inspection**
10. **Update as-built documents**
11. **Use permit issuance**



7. FROM “AS-IS” TO “TO-BE”: CHEK METHODOLOGY



7. FROM “AS-IS” TO “TO-BE”: CHEK METHODOLOGY

Lack of Transparency

Transparency is lacking in the traditional permit process, leading to confusion and delays for stakeholders. The opaque nature of the process creates challenges for effective collaboration and decision-making.

Impact on Urban Development

These challenges have an impact on urban development, as they impede the timely completion of projects and hinder sustainable growth in cities, affecting overall livability.

Inefficiencies

The traditional building permit process is marred by inefficiencies, causing delays and hindering urban development projects. Manual paperwork and lack of digitization contribute to this issue.

CHEK DIGITAL BUILDING PERMIT

OBJECTIVES

KPIs

Municipalities

Premise

TRANSPARENT
The process has to be transparent from both sides (applicant and municipality)

CLEAR
Avoid confusing steps or procedures during the application

EFFICIENT
Reduce the time frames of the application process and the number of steps?

SCALABLE
Can be easily adapted for a larger number of municipalities

APPLICABLE
Possible to be applied considering the current resources

ADAPTABLE
Adaptable enough to fulfill the needs of all the different municipalities participating (and more)

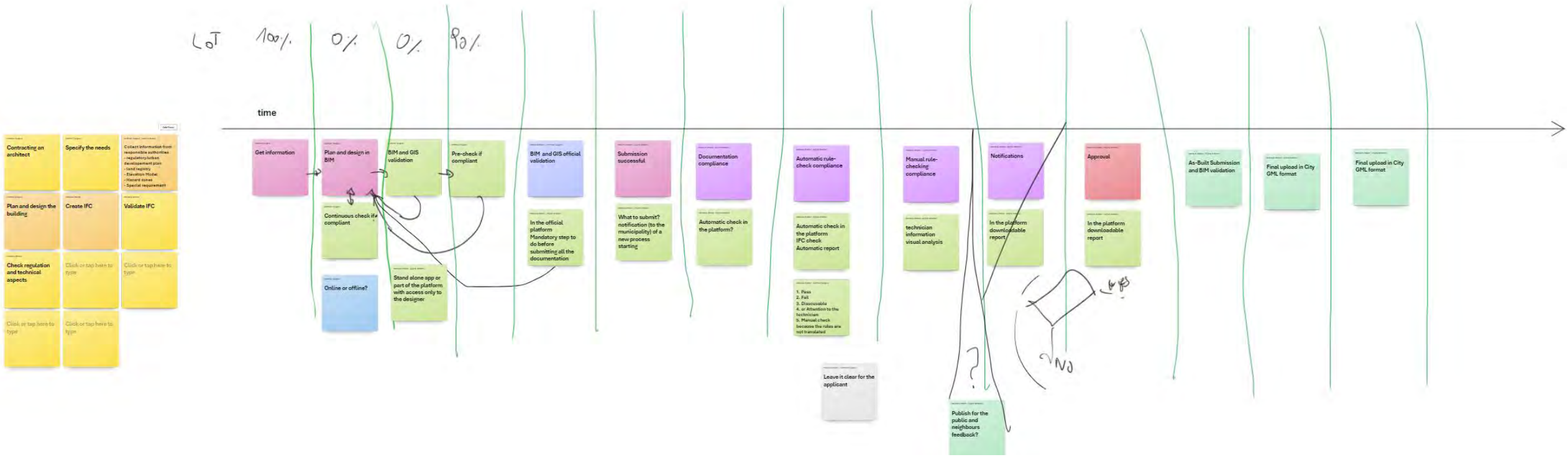
EXTENDABLE
Open to the possibility to be improved and extended easily

PARTITIONABLE
Having the possibility of splitting up, re-arranging without loosing its functionalities

FLEXIBLE
Possible to make changes according to the needs of the municipalities

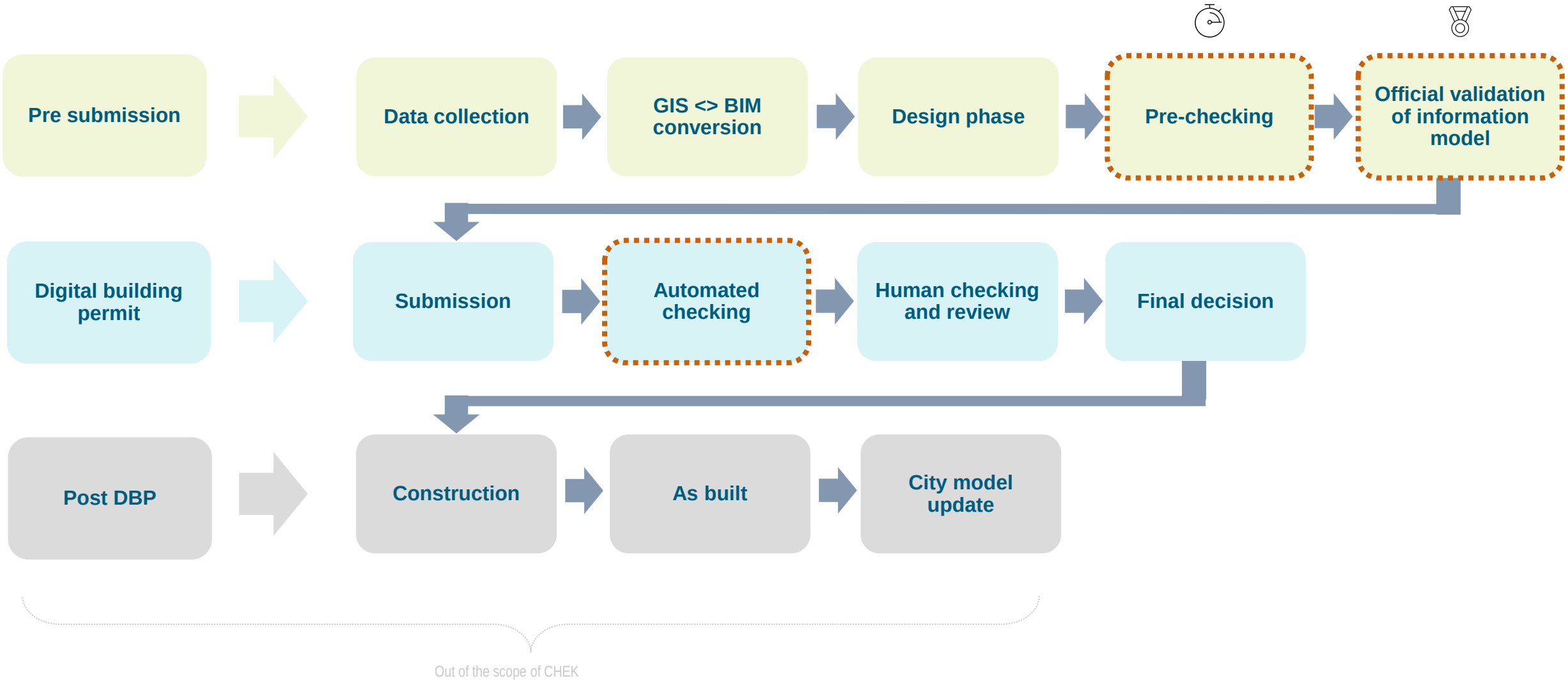
7. FROM “AS-IS” TO “TO-BE”: CHEK METHODOLOGY

Brainstorming the new process



8. CHEK TO-BE PROCESS MAP OVERVIEW

Defining the new process



8. CHEK TO-BE PROCESS MAP OVERVIEW

Digitalized Framework

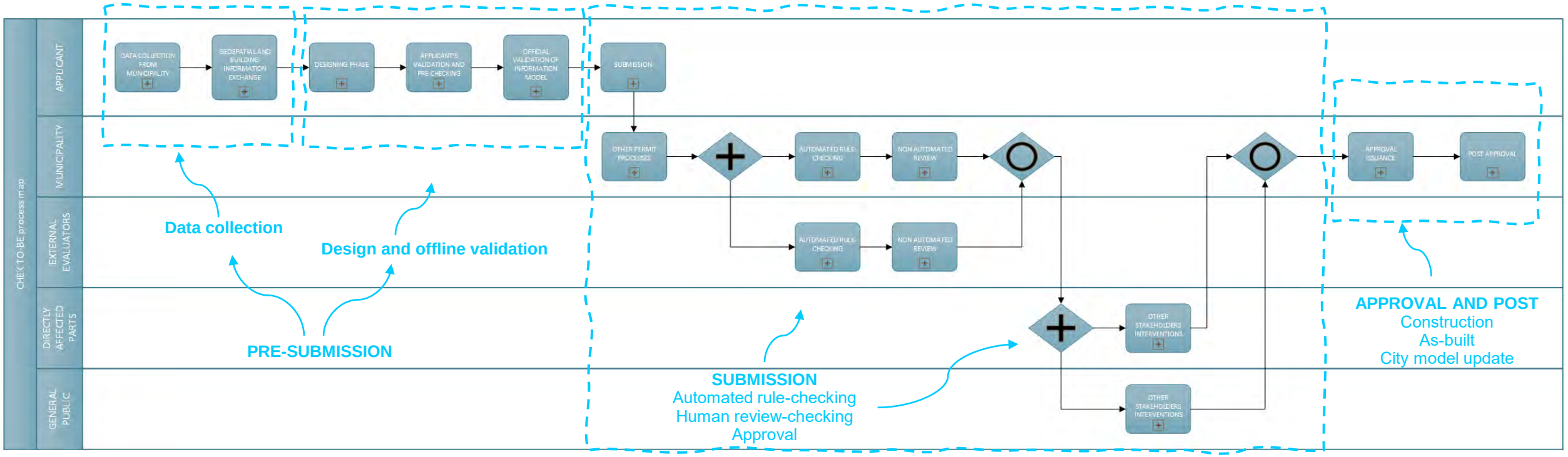
The framework encompasses a comprehensive approach to digitize and modernize the building permit process, leveraging digital platforms and BIM to streamline workflows and ensure data management.

Automated Compliance Checks

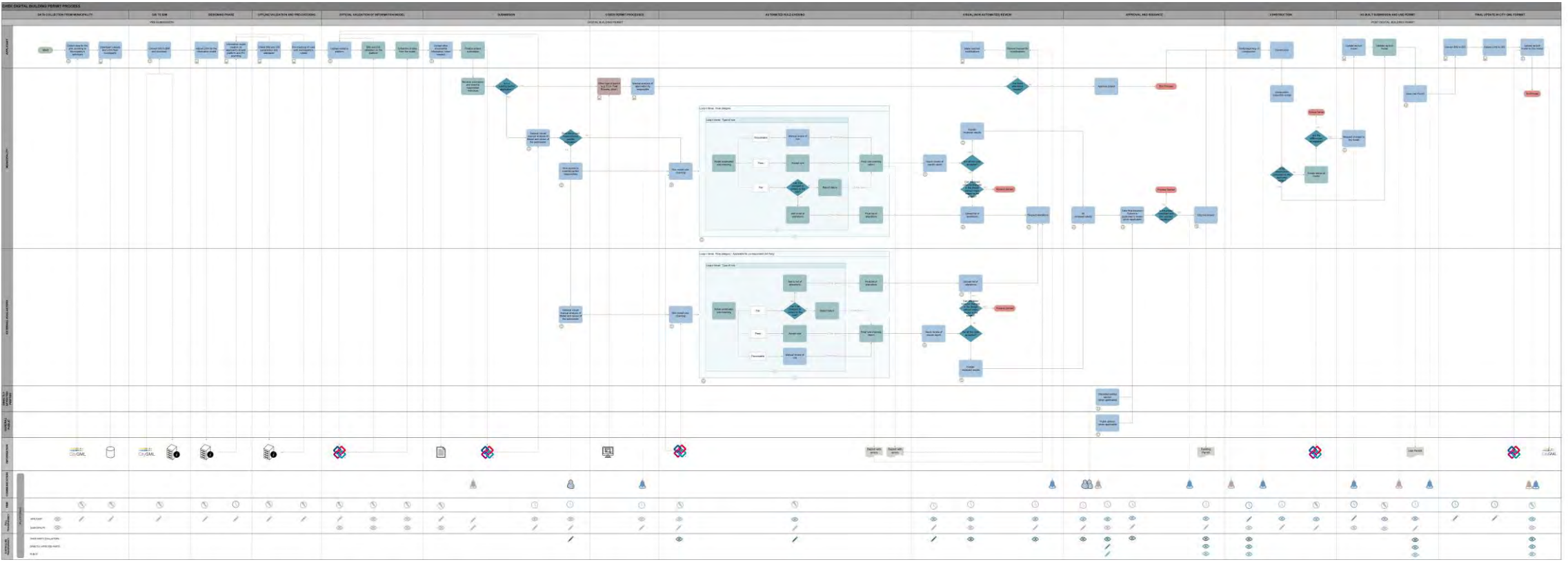
Through advanced digital solutions, compliance checks can be automated, reducing human errors and ensuring that projects adhere to building codes, safety regulations, and environmental standards.

Enhanced Collaboration

The proposed digital approach fosters better collaboration among stakeholders, enabling real-time sharing of information, and facilitating smoother communication and decision-making during the building permit process.



8. CHEK TO-BE PROCESS MAP OVERVIEW

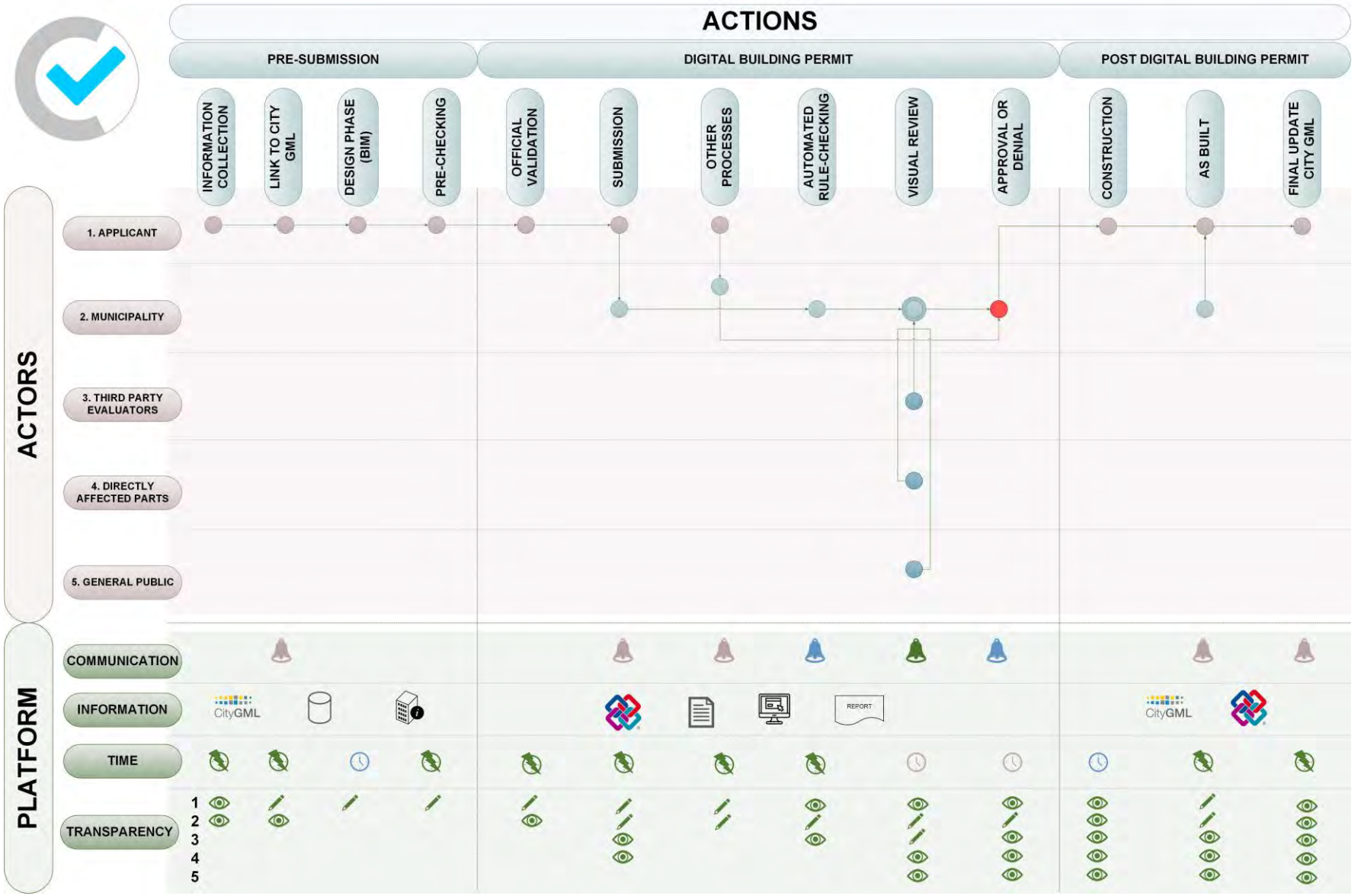




CHEK To-be Digital Building Permit process map

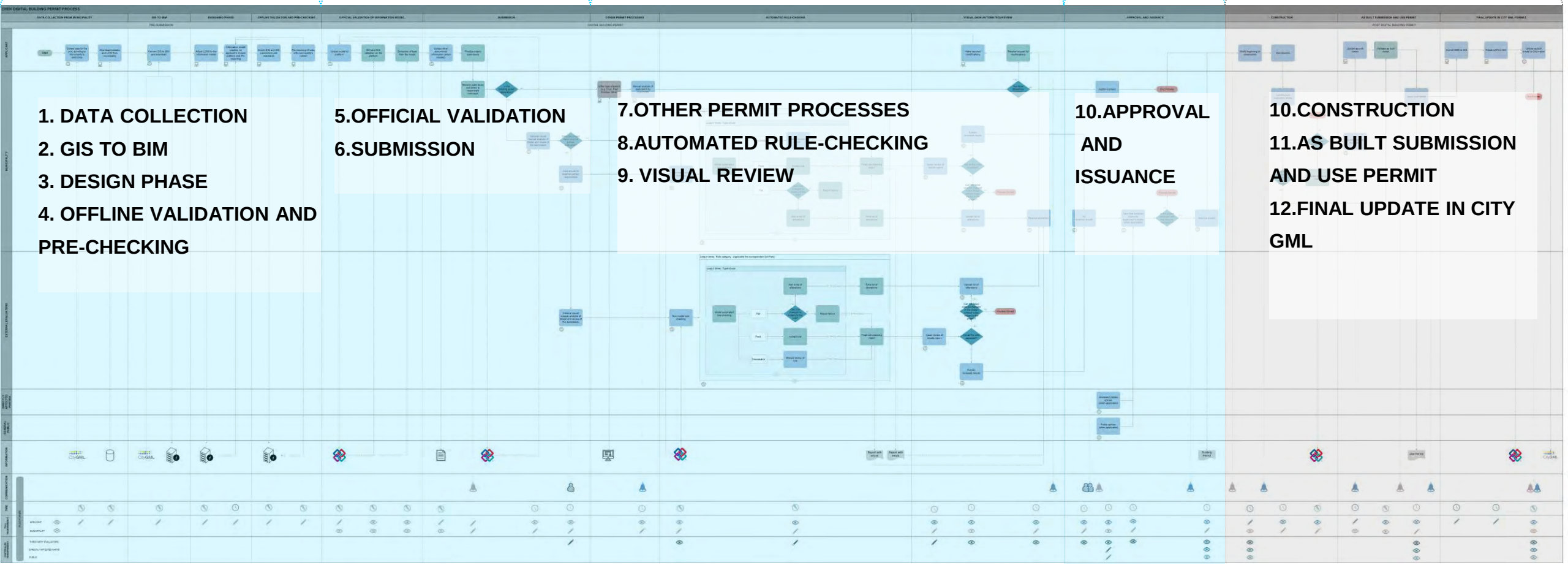
8. CHEK TO-BE PROCESS MAP OVERVIEW

TO BE process map



8. CHEK TO-BE PROCESS MAP OVERVIEW

PRE-SUBMISSION | SUBMISSION | CHECKING | APPROVAL | POST-BP



1. DATA COLLECTION
2. GIS TO BIM
3. DESIGN PHASE
4. OFFLINE VALIDATION AND PRE-CHECKING

5.OFFICIAL VALIDATION
6.SUBMISSION

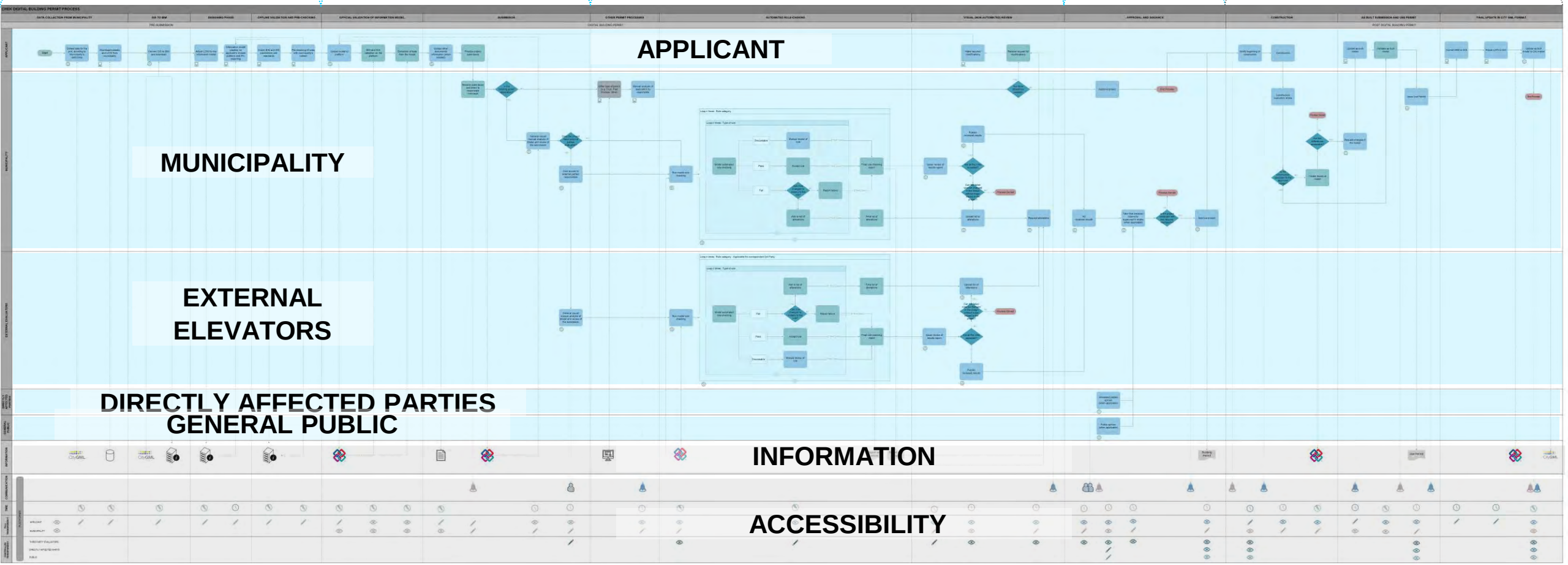
7.OTHER PERMIT PROCESSES
8.AUTOMATED RULE-CHECKING
9. VISUAL REVIEW

10.APPROVAL AND ISSUANCE

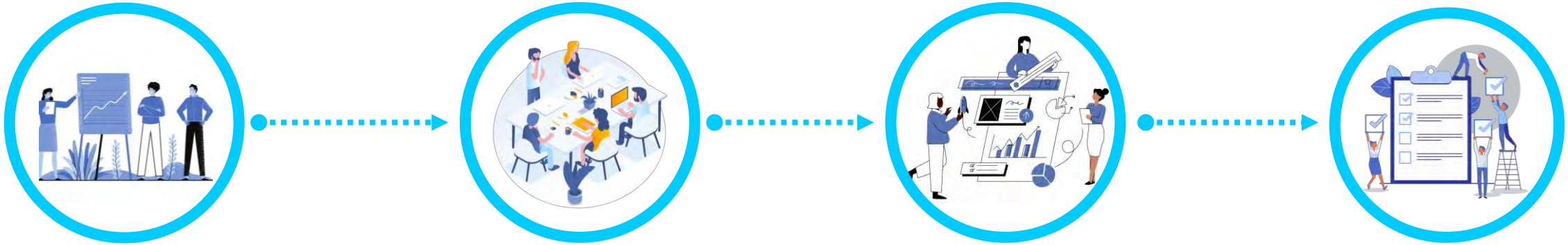
10.CONSTRUCTION
11.AS BUILT SUBMISSION AND USE PERMIT
12.FINAL UPDATE IN CITY GML

8. CHEK TO-BE PROCESS MAP OVERVIEW

PRE-SUBMISSION | SUBMISSION | CHECKING | APPROVAL | POST-BP



8. TO-BE PROCESS TESTING

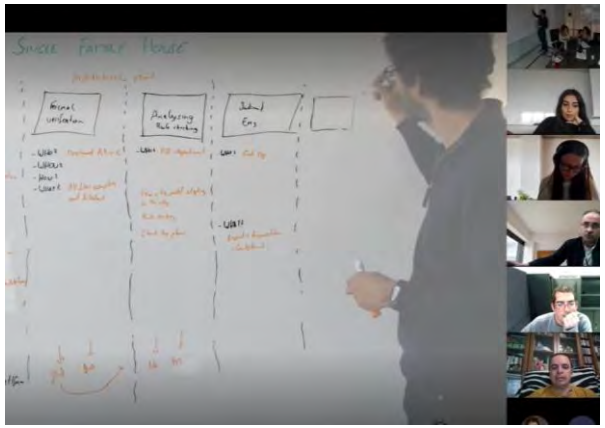


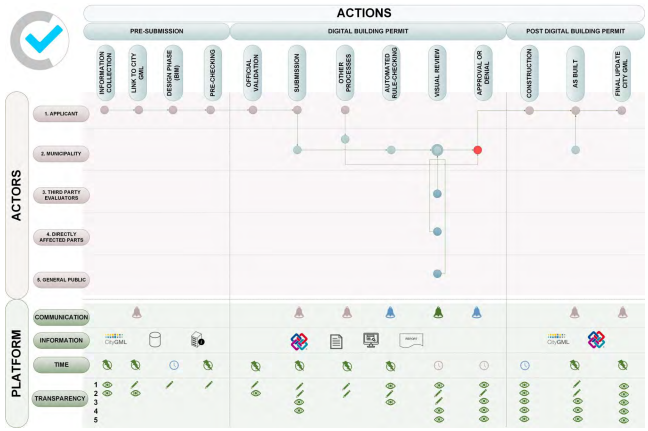
Understand

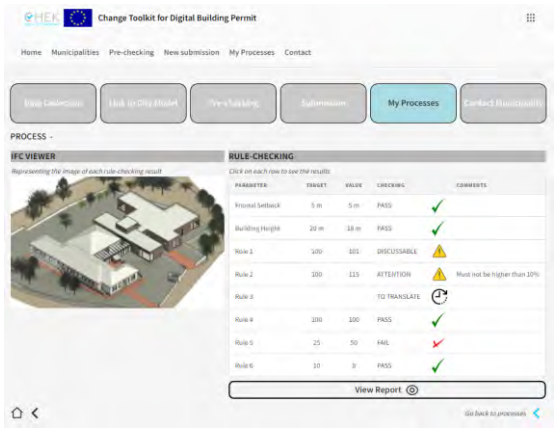
Define and Sketch

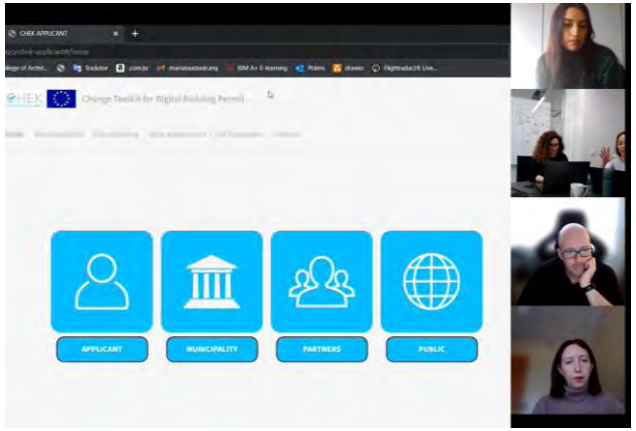
Prototype

Test

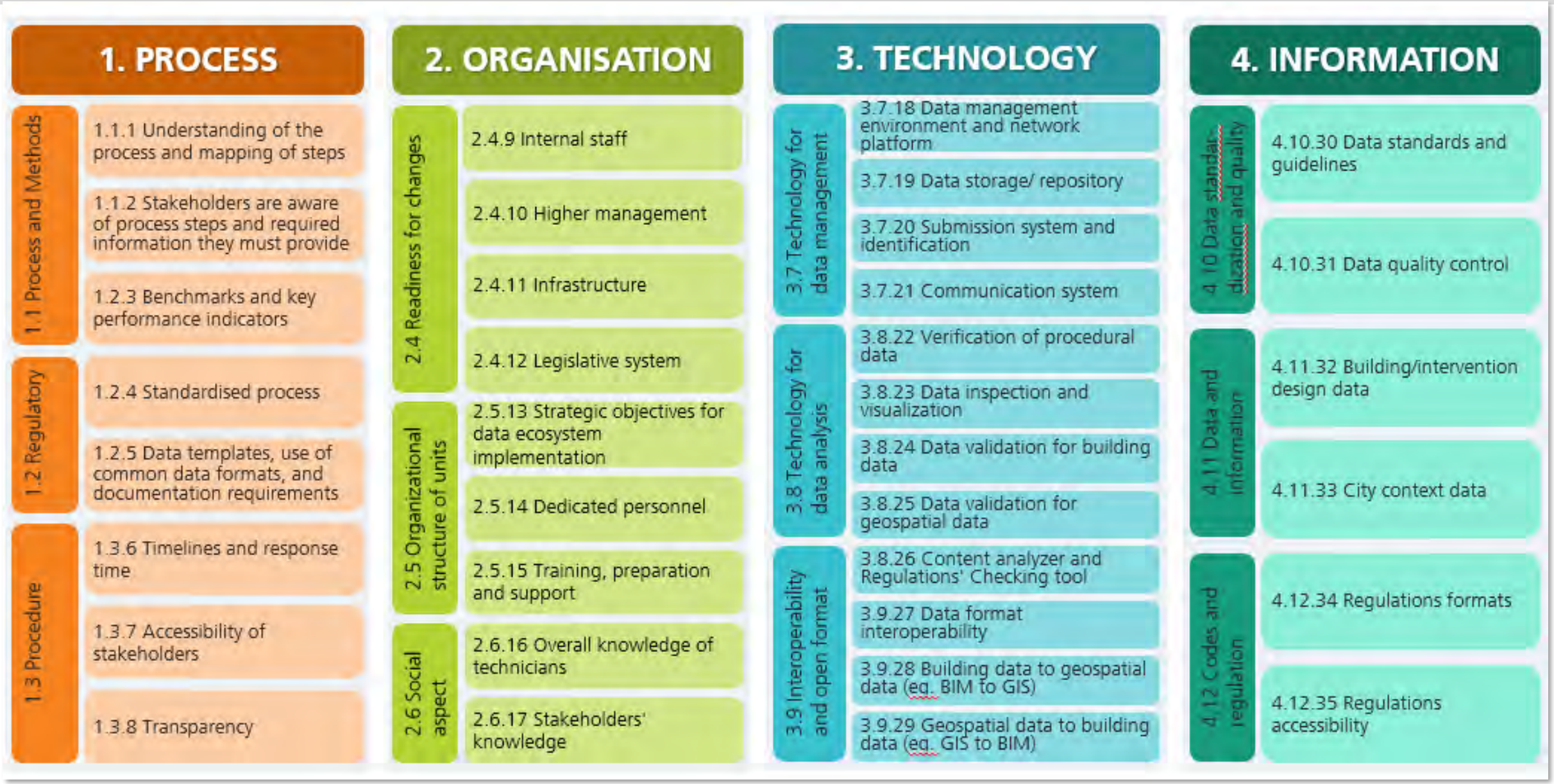








9. The CHEK DBP maturity model – CHEK Toolkit



9. The CHEK DBP roadmap – CHEK Toolkit

Dependencies

Actions

Resources available*

Project control

Timeline

Key maturity areas

KMA	DEPENDS ON	ACTIVITY	CHEK TOOLS	AVAILABLE MATERIAL	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
1.1.1		Implement platform for tracking processes, connect all internal systems to the platform and allow time tracking.			1	5	0	0	0%
1.1.2	1.1.1	Create a detailed process map with steps of the process, using the CHEK VA. Make the process map public available.			6	3	0	0	0%
1.2.3.1	1.1.1	Define KPIs to be achieved			8	2	0	0	0%
1.2.3.2	1.2.3.1	Set up measurements of KPI's on the management platform			6	4	0	0	0%
1.2.4	1.1.2	Create guidelines for each step of the process (use CHEK guidelines as references). Make guidelines available for internal and external stakeholders. Control the privacy of external guidelines.			9	3	0	0	0%
1.2.5.1	1.1.1	Implement the use of BIMserver.centre to manage project models.			8	2	0	0	0%
1.2.5.2	1.2.5.1	Use APIs to connect BIMserver.centre to municipality's platform.			6	1	0	0	0%
1.2.5.3	1.2.5.1	Require IFC and GIS as data exchange files on the process. Follow CHEK guidelines for data structure and implementation.			8	2	0	0	0%
1.3.6	1.3.8	Communicate timelines for all steps of the process. Start monitoring and reporting the timelines of the processes managed on the platform.			19	2	0	0	0%
1.3.7	1.2.5.2 1.2.6 1.2.5.3	Implement data sharing on BIMserver.centre. Include stakeholders and manage their permissions inside the platform.			12	2	0	0	0%
1.3.8	1.3.7	Connect BIMserver.centre to stakeholder's platforms with the APIs			14	5	0	0	0%
2.4.9		Make online basic trainings available for staff members. The training should cover what is data technology, what are the advantages and how to implement. Require minimum participation of 50% of staff.			1	4	0	0	0%
2.4.10	1.1.2	Create strategic plan for implementing the digital process. Use CHEK tools to support the decision making. Use the CHEK VA to create an initial roadmap and the adjust according to available resources.			9	4	0	0	0%
2.4.11.1	1.1.1	Make an assessment of the hardware and software used on the steps of the process, defining the current situation of the infrastructure.			8	4	0	0	0%
2.4.11.2	2.4.10 2.4.11.1	Create a list of software needed for each step of the digital process. Add the hardware/software requirements for them.			13	3	0	0	0%
2.4.11.3	2.4.11.2	Update the hardware and software of the organization based on the specifications needed.			16	4	0	0	0%
2.4.12		Activity 12 (Legislative system)			1	2	0	0	0%
2.5.13	2.4.10	Update vision and strategic plan to include digital processes and data technology. Share the vision and goals with the whole institution.			13	4	0	0	0%
2.5.14	2.5.13	Create a small dedicated team of 3-5 staff member with good knowledge in BIM or GIS, to be leading the implementation of the digital process ion the institution.			17	5	0	0	0%
2.5.15	2.5.14	Provide training to dedicated implementation group staff on BIM/GIS. Use CHEK training packages for support.			22	4	0	0	0%

10. The scalability objective

How to make the process mapping scalable & automated?

11. CHEK Virtual Assistant

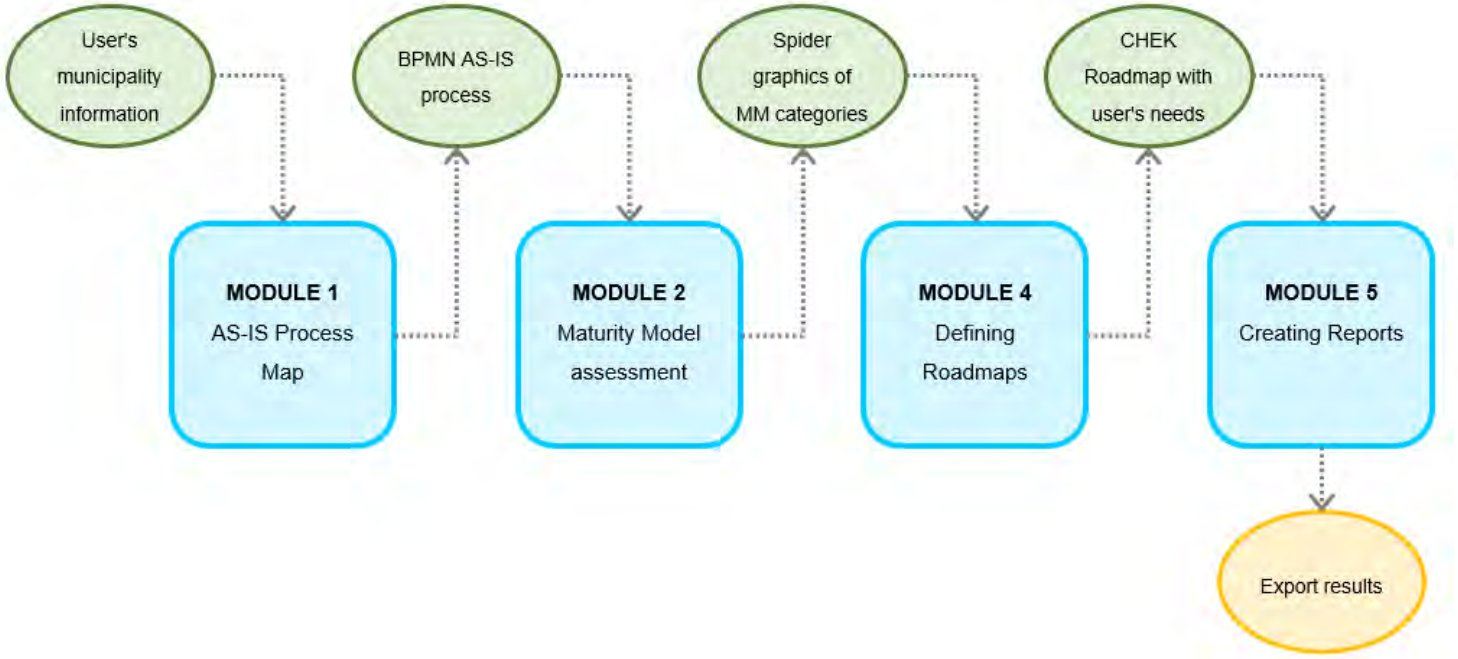
How to successfully build a scalable transition process?

- 1 EU PROJECT
- DBP & PROCESS EXPERTS
- 4 MUNICIPALITIES
- MORE THAN 8 TECHNICIANS
- 8 WORKSHOPS
- LONG ANALYSIS PROCESS
- …
- 2 YEARS

HOW DO WE MAKE IT SCALABLE?

11. CHEK VA & live demo

AI Virtual Assistant at your service





AI Virtual Assistant

CHEK

Change Management Assistant

Log in to start improving your Building Permit process.

e-mail

password

Login

Don't have an account? Register here

Funded by the European Union

CHEK

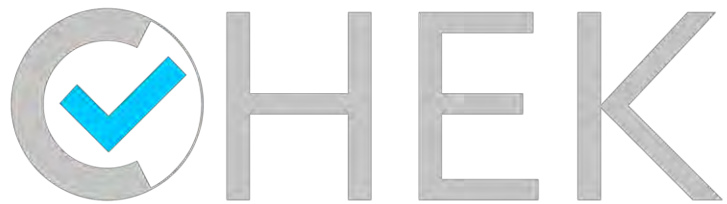
Fraunhofer ITALIA

INTEGRATING TO-BE MAP & INFRASTRUCTURE

MAP YOUR PROCESS!

CHEK Virtual-Assistant





DIGITAL BUILDING PERMIT

DIGITAL BUILDING PERMIT

CHEK Process Map

CHEK Summer Course

Miguel Azenha, José Granja, Bruno Muniz, André Lisboa, Luciana Sobral, Chiara Gatto

ISISE, University of Minho, PORTUGAL

Funded by
the European Union

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2. Designers Process Map
3. Municipalities Process Map
4. Training Videos
    a. Designers
    b. Municipalities

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1. The CHEK Toolkit

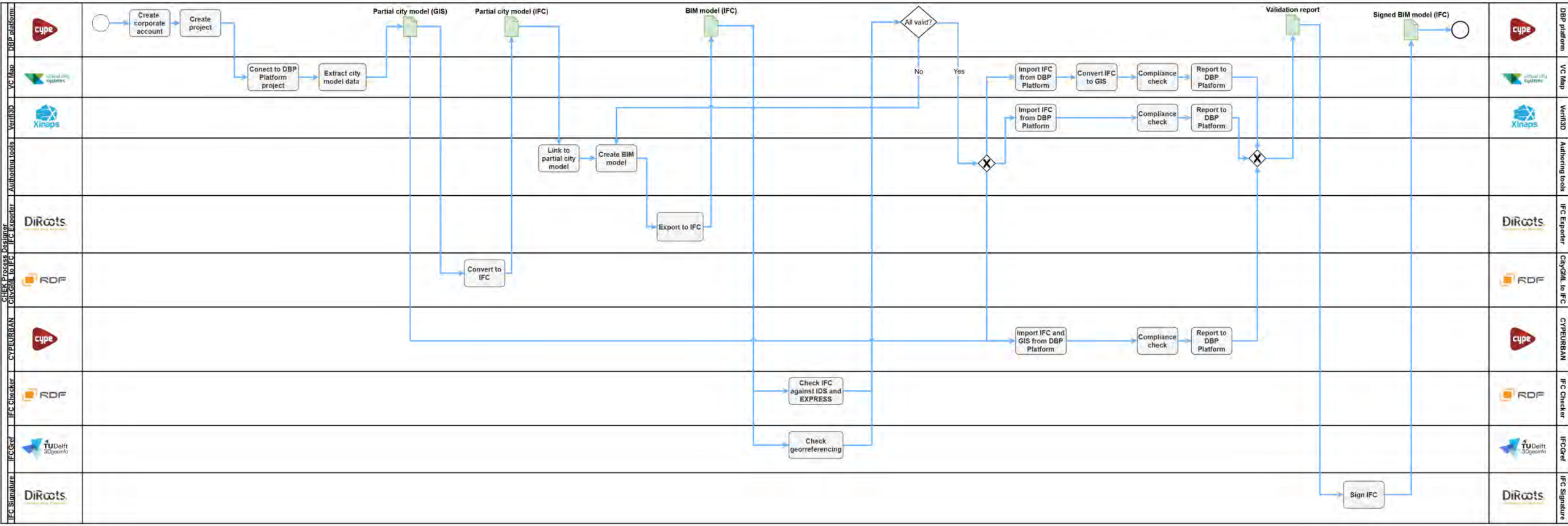
CHEK toolkit	Developer
CityGML to IFC	RDF
IFC Checker	
CityGML/CityJSON Validation	Open Geospatial Consortium
IFCGref	TU Delft 3Dgeoinfo
BIM2GEO	
CYPEURBAN	cype
DBP platform	
IFC Exporter	DiRoots connecting the dots
IFC Signature	
VC Map	virtual city systems
Verifi3D	Xinaps

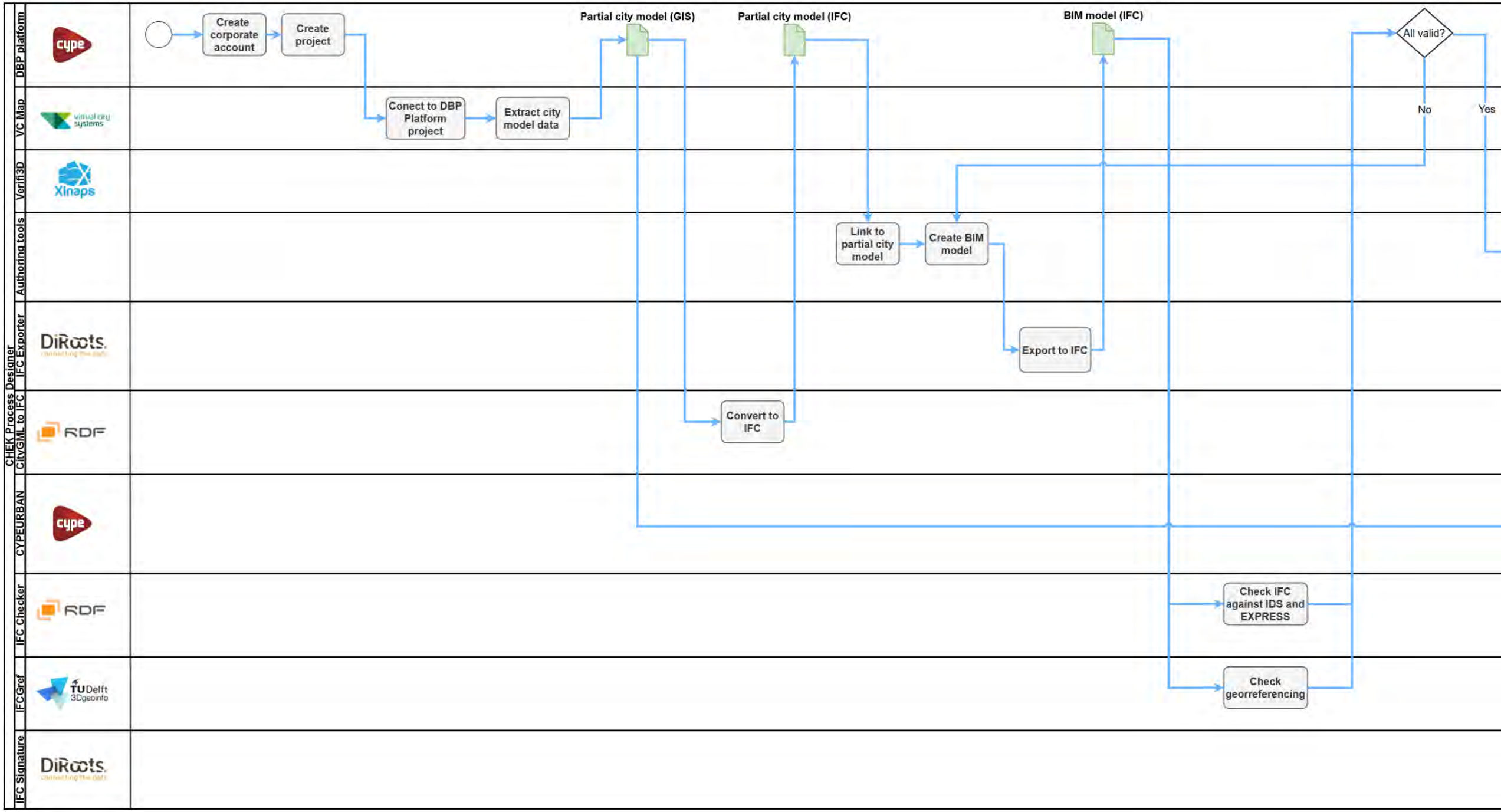
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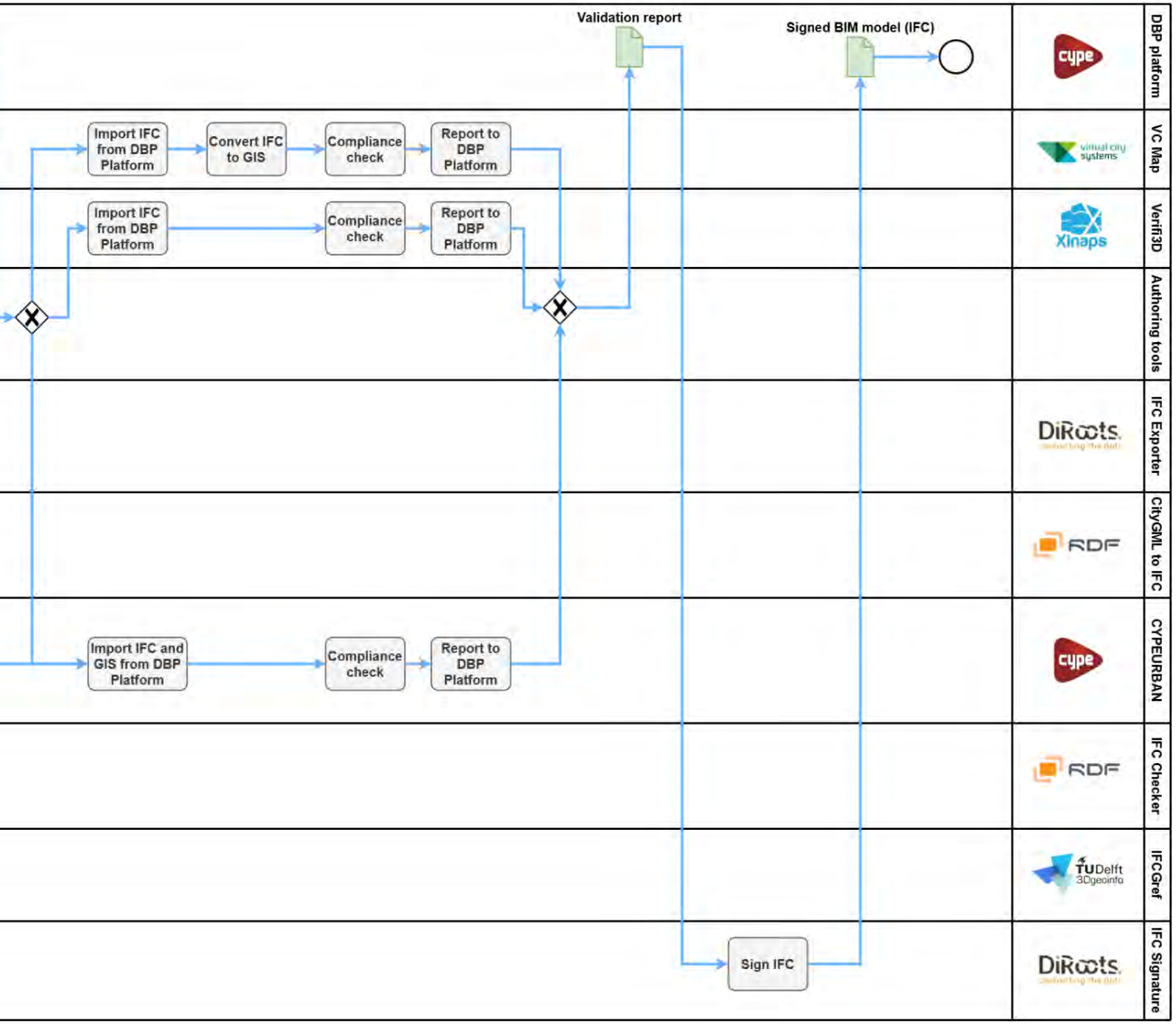
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    a. Designers
    b. Municipalities



2. Designers Process Map




CHEK Process Designer
DBP platform
VC Map
Verifi3D
Authoring tools
IFC Exporter
CityGML to IFC
CYPEURBAN
IFC Checker
IFCGref
IFC Signature
Create corporate account
Create project
Conect to DBP Platform project
Extract city model data
Partial city model (GIS)
Partial city model (IFC)
BIM model (IFC)
Link to partial city model
Create BIM model
Export to IFC
Convert to IFC
All valid?
No
Yes
Check IFC against IDS and EXPRESS
Check georreferencing


Validation report
Signed BIM model (IFC)
Import IFC from DBP Platform
Convert IFC to GIS
Compliance check
Report to DBP Platform
Import IFC from DBP Platform
Compliance check
Report to DBP Platform
Import IFC and GIS from DBP Platform
Compliance check
Report to DBP Platform
Sign IFC
DBP platform
VC Map
Verifi3D
Authoring tools
IFC Exporter
CityGML to IFC
CYPEURBAN
IFC Checker
IFCGref
IFC Signature

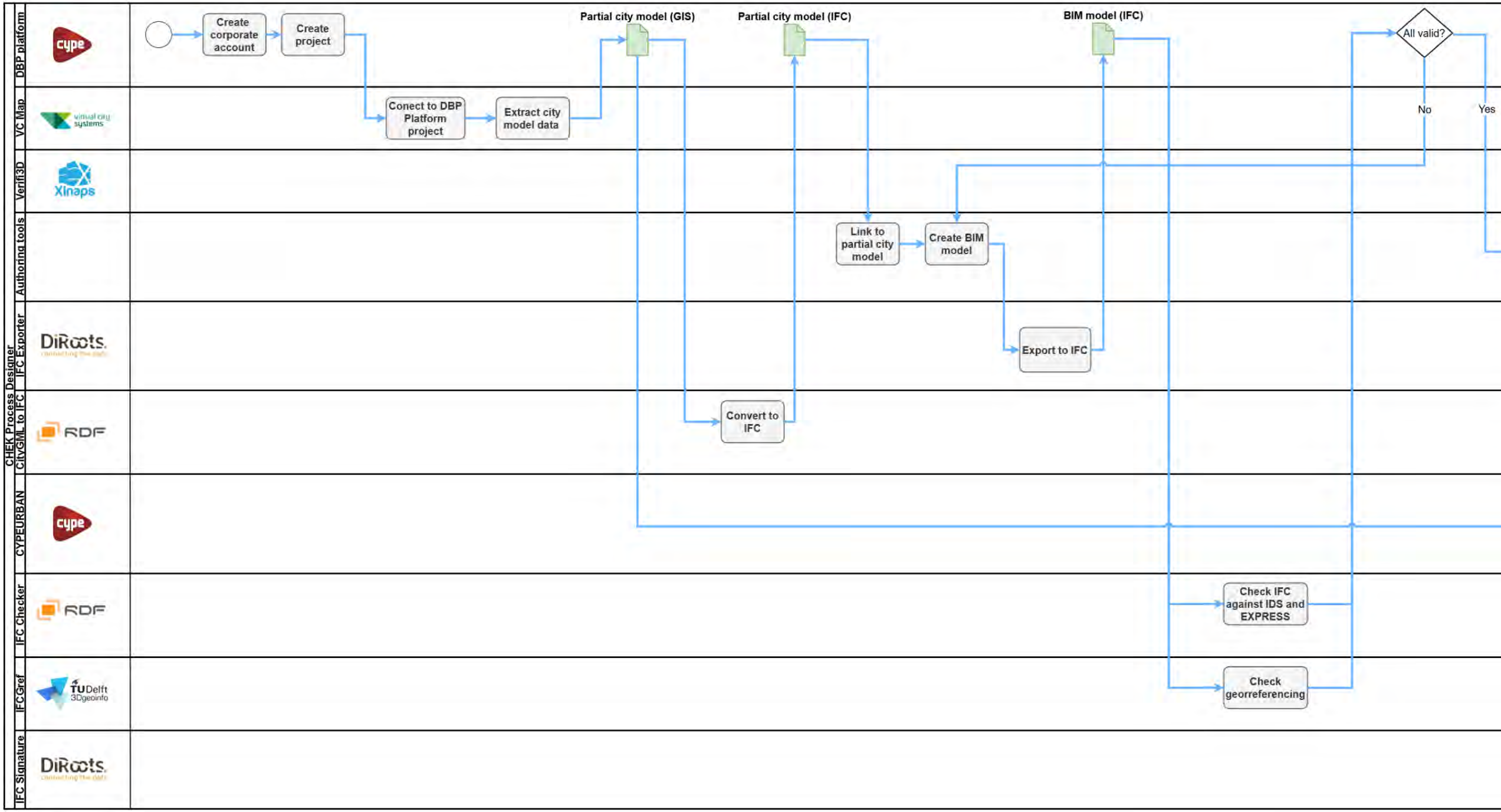
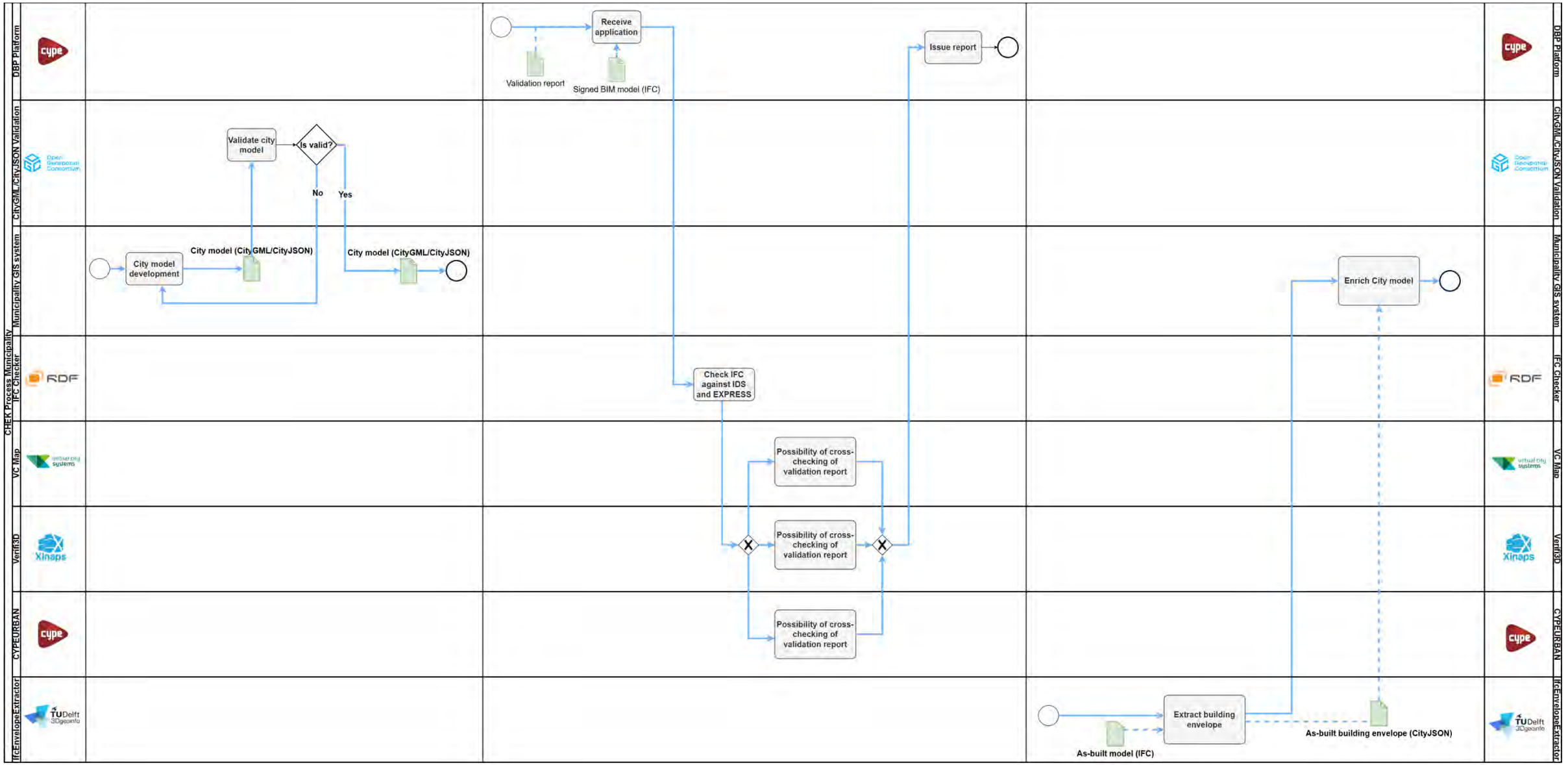

CHEK Process Designer
DBP platform
VC Map
Verifi3D
Authoring tools
IFC Exporter
CityGML to IFC
CYPEURBAN
IFC Checker
IFCGref
IFC Signature
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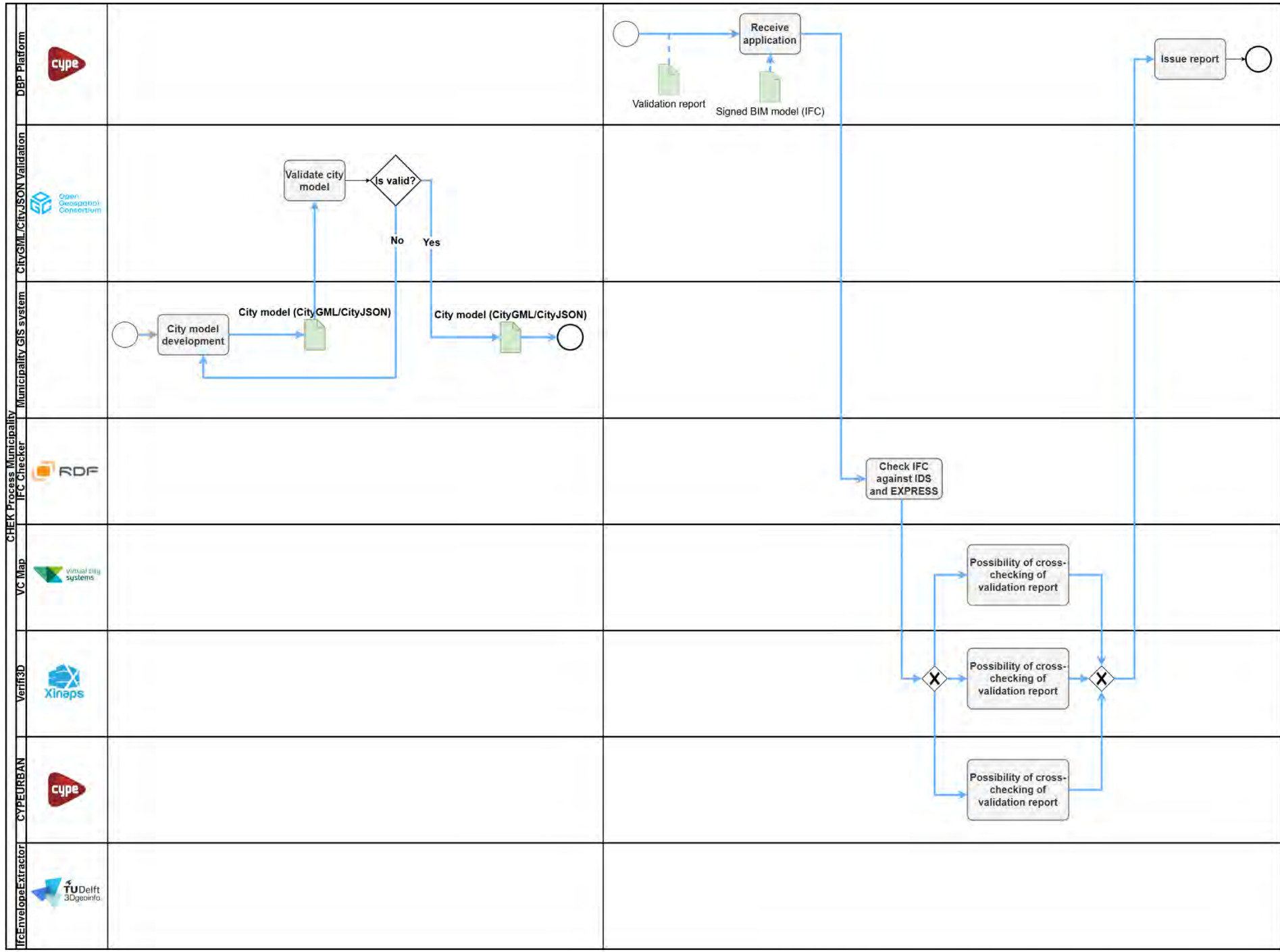
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    b. Municipalities



3. Municipalities Process Map




CHEK Process Municipality
DBP Platform
CityGML/CityJSON Validation
Municipality GIS system
IFC Checker
VC Map
Verifit3D
CYPEURBAN
IfcEnvelopeExtractor
Receive application
Validation report
Signed BIM model (IFC)
Issue report
Validate city model
Is valid?
No
Yes
City model development
City model (CityGML/CityJSON)
City model (CityGML/CityJSON)
Check IFC against IDS and EXPRESS
Possibility of cross-checking of validation report
Possibility of cross-checking of validation report
Possibility of cross-checking of validation report

DBP Platform
CityGML/CityJSON Validation
Municipality GIS system
IFC Checker
VC Map
Verif3D
CYPEURBAN
IfcEnvelopeExtractor
Enrich City model
Extract building envelope
As-built model (IFC)
As-built building envelope (CityJSON)

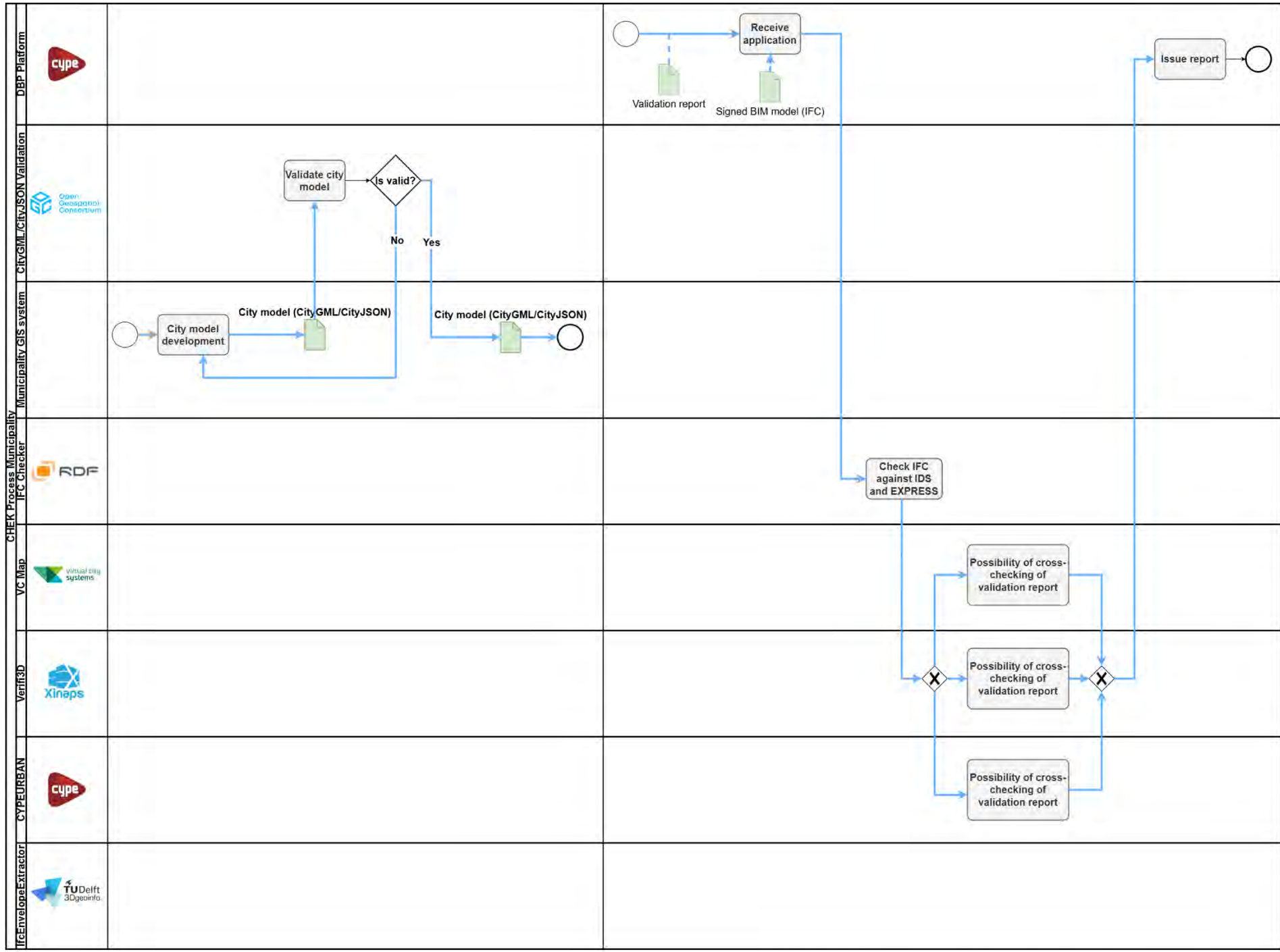
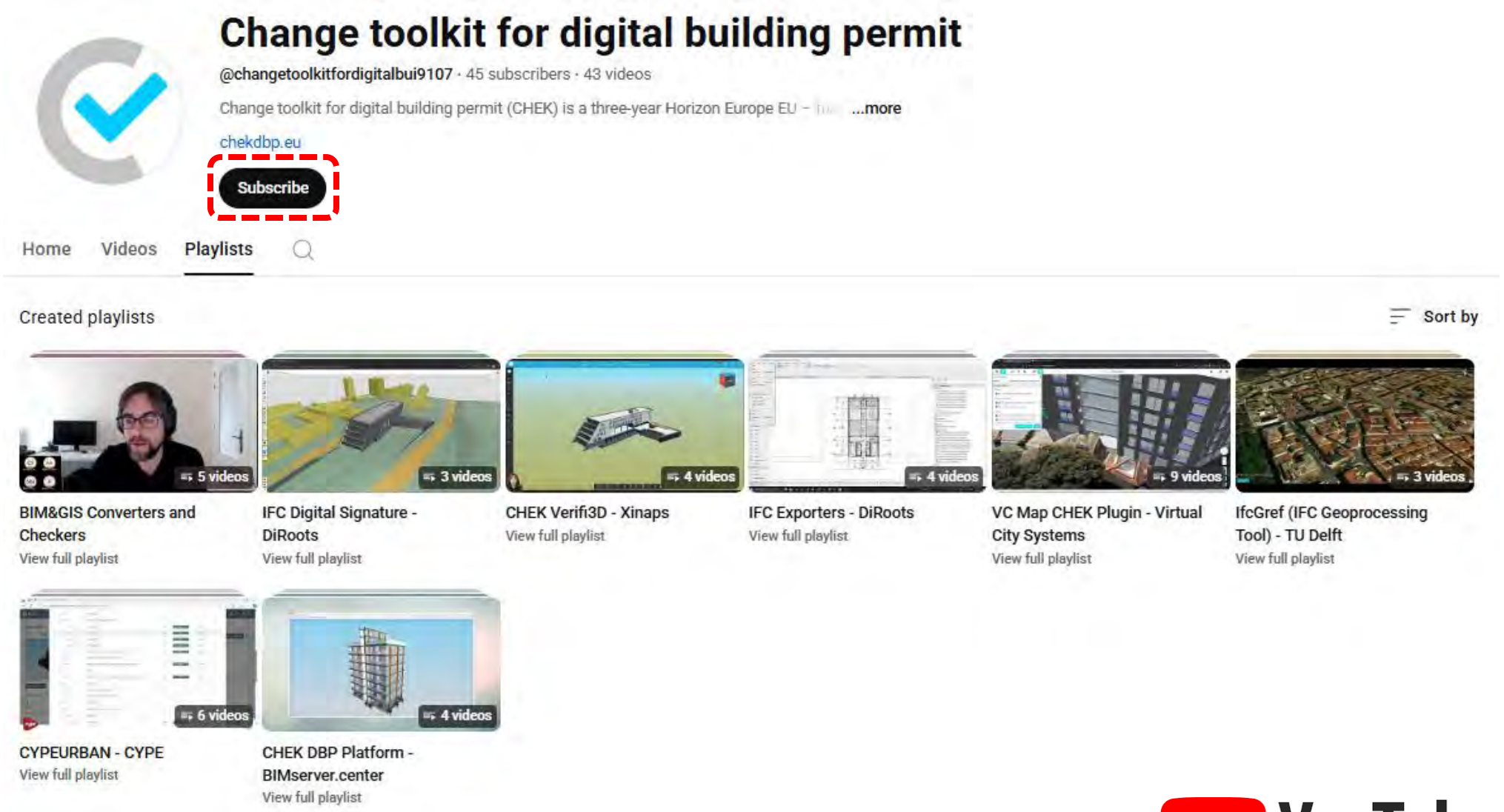

CHEK Process Municipality
DBP Platform
CityGML/CityJSON Validation
Municipality GIS system
IFC Checker
VC Map
Verifit3D
CYPEURBAN
IfcEnvelopeExtractor
Receive application
Validation report
Signed BIM model (IFC)
Issue report
Validate city model
Is valid?
No
Yes
City model development
City model (CityGML/CityJSON)
City model (CityGML/CityJSON)
Check IFC against IDS and EXPRESS
Possibility of cross-checking of validation report
Possibility of cross-checking of validation report
Possibility of cross-checking of validation report

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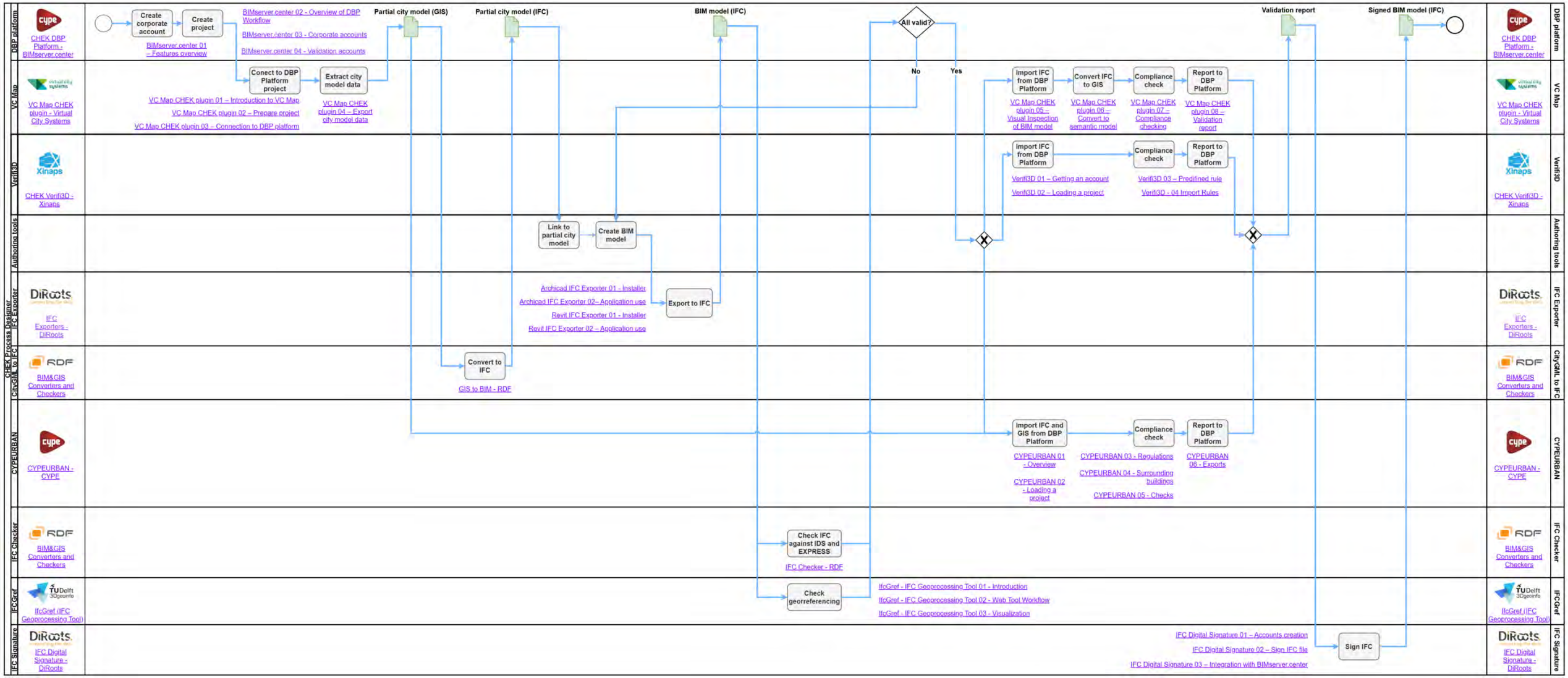
1. The CHEK toolkit
2. Designers Process Map
3. Municipalities Process Map
4. Training Videos
    a. Designers*
    b. Municipalities*

**Download both Process Maps (for Designers and Municipalities) from the e-learning platform and browse the CHEK toolkit videos on YouTube!!!*

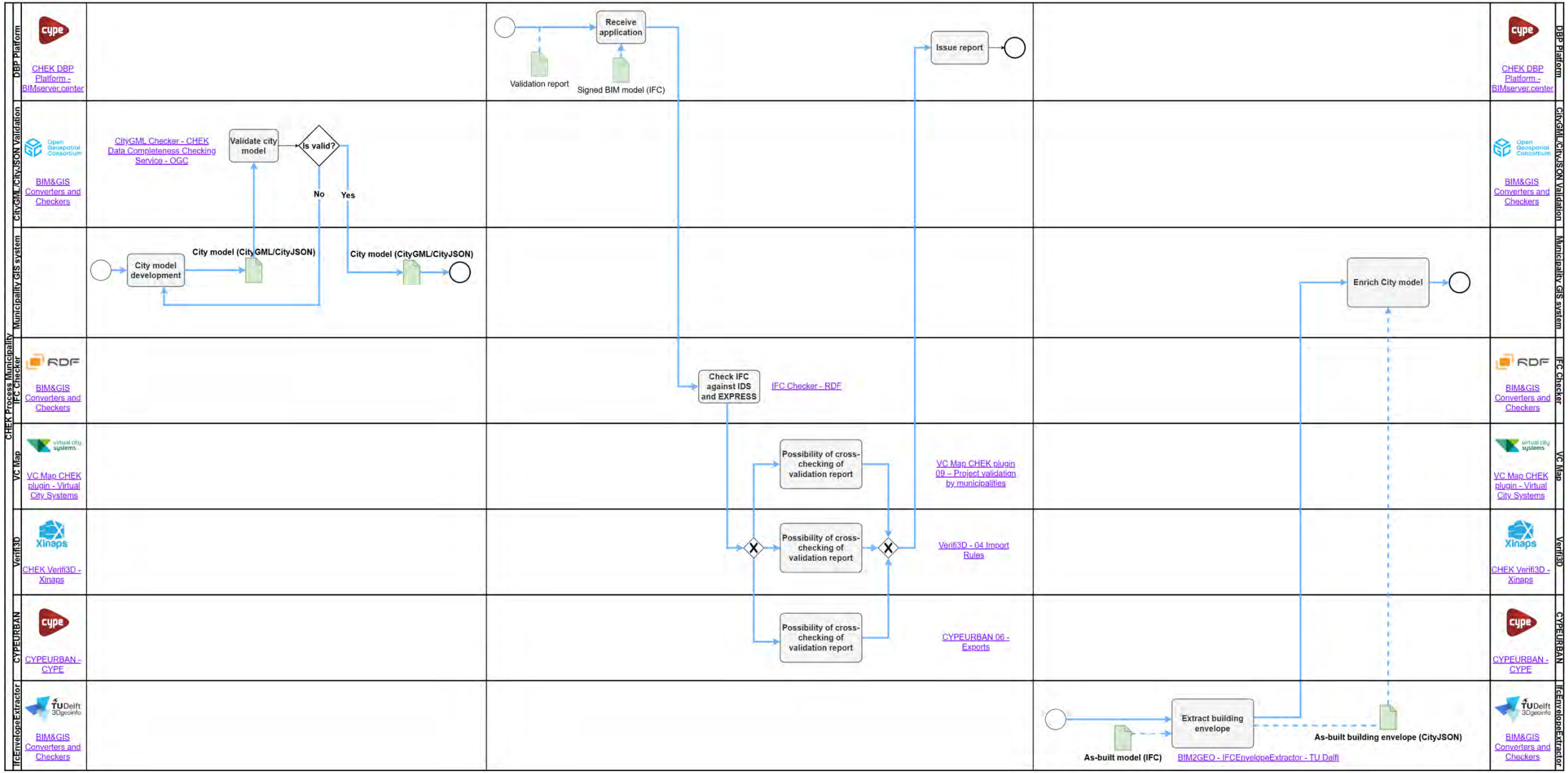
4. Training Videos



4a. Training Videos - Designers



4b. Training Videos - Municipalities




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CHEK technology architecture:
Achieving interoperability for a modular approach



MUNICIPALITY



DESIGNER



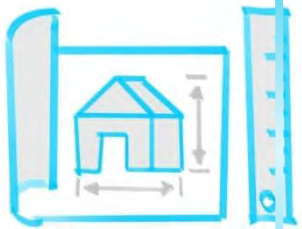
MUNICIPALITY



DESIGNER



MUNICIPALITY



DESIGNER

Digital signature

BIM

IFC

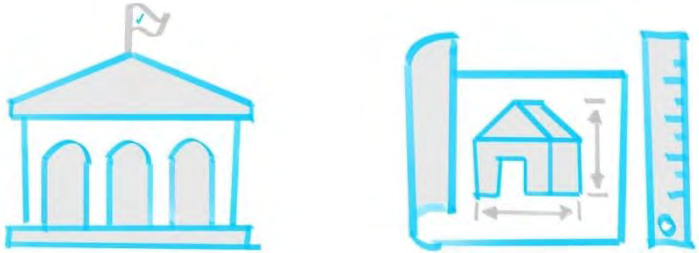
BIM to GIS

GIS

CityGML

Parametrization of rules

Scalability



GIS to BIM

Open Formats

API

Rule Checking

BUILDING

Urban Plans Zoning & Building Use

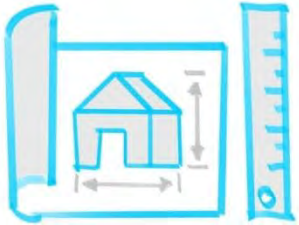
MAPS

TERRAIN

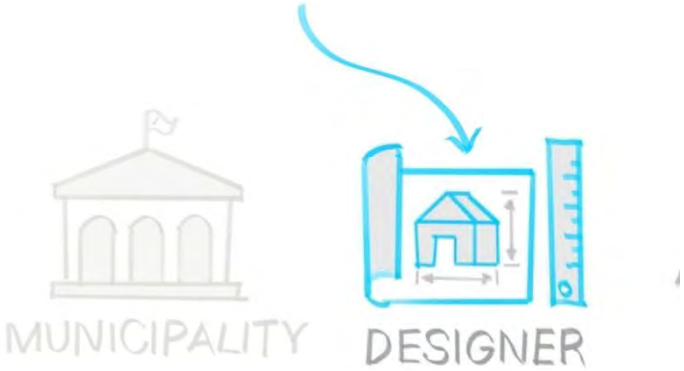
Georreferencing

MUNICIPALITY

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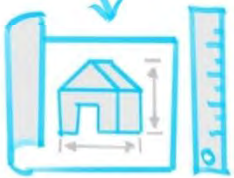


TY DESIGNER


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DESIGNER
BIMserver.center
Corporate
Project

BIMserver.center

MUNICIPALITY



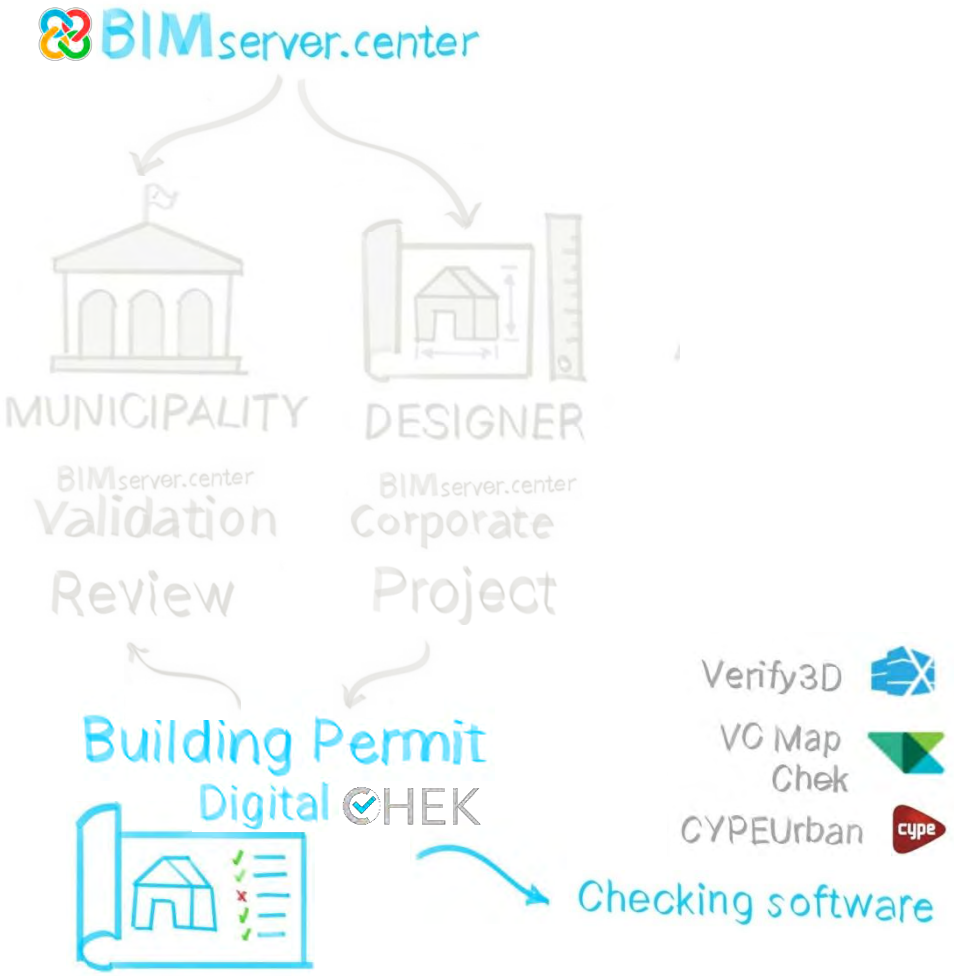
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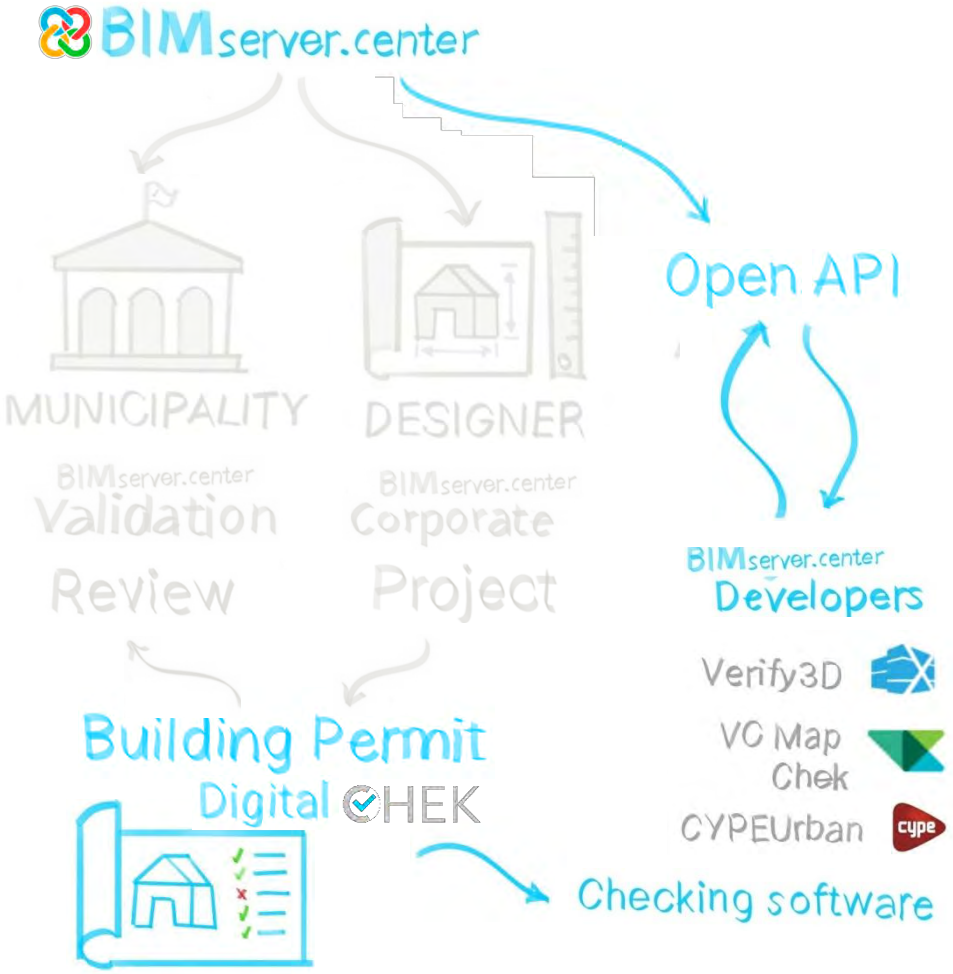
BIMserver.center
Corporate
Project

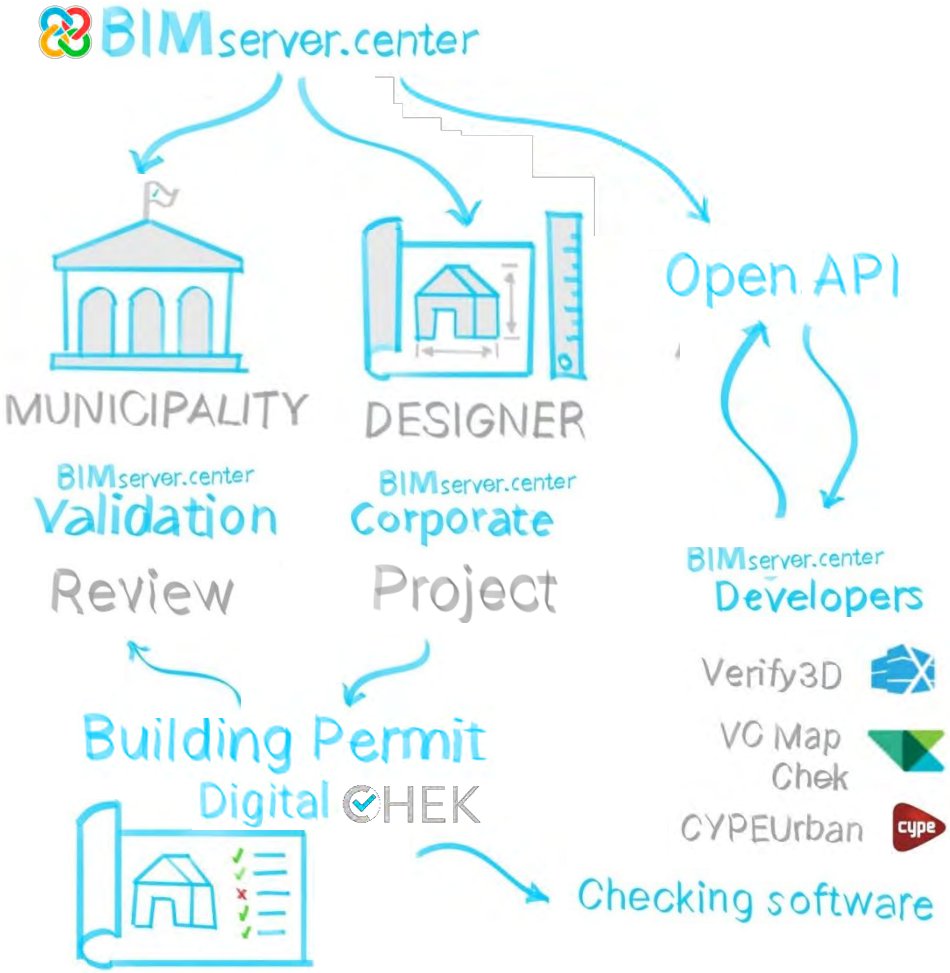
Building Permit
Digital CHEK

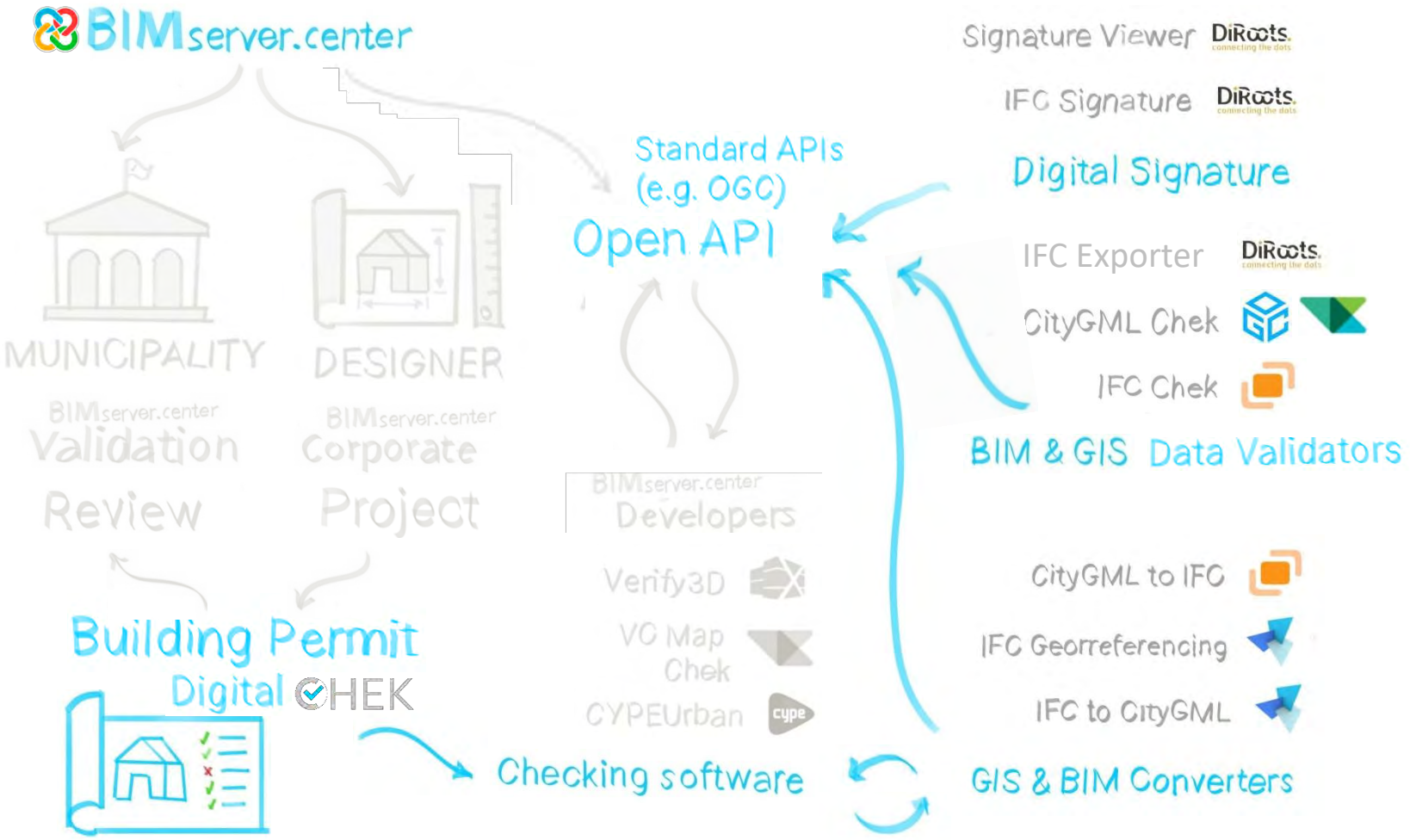


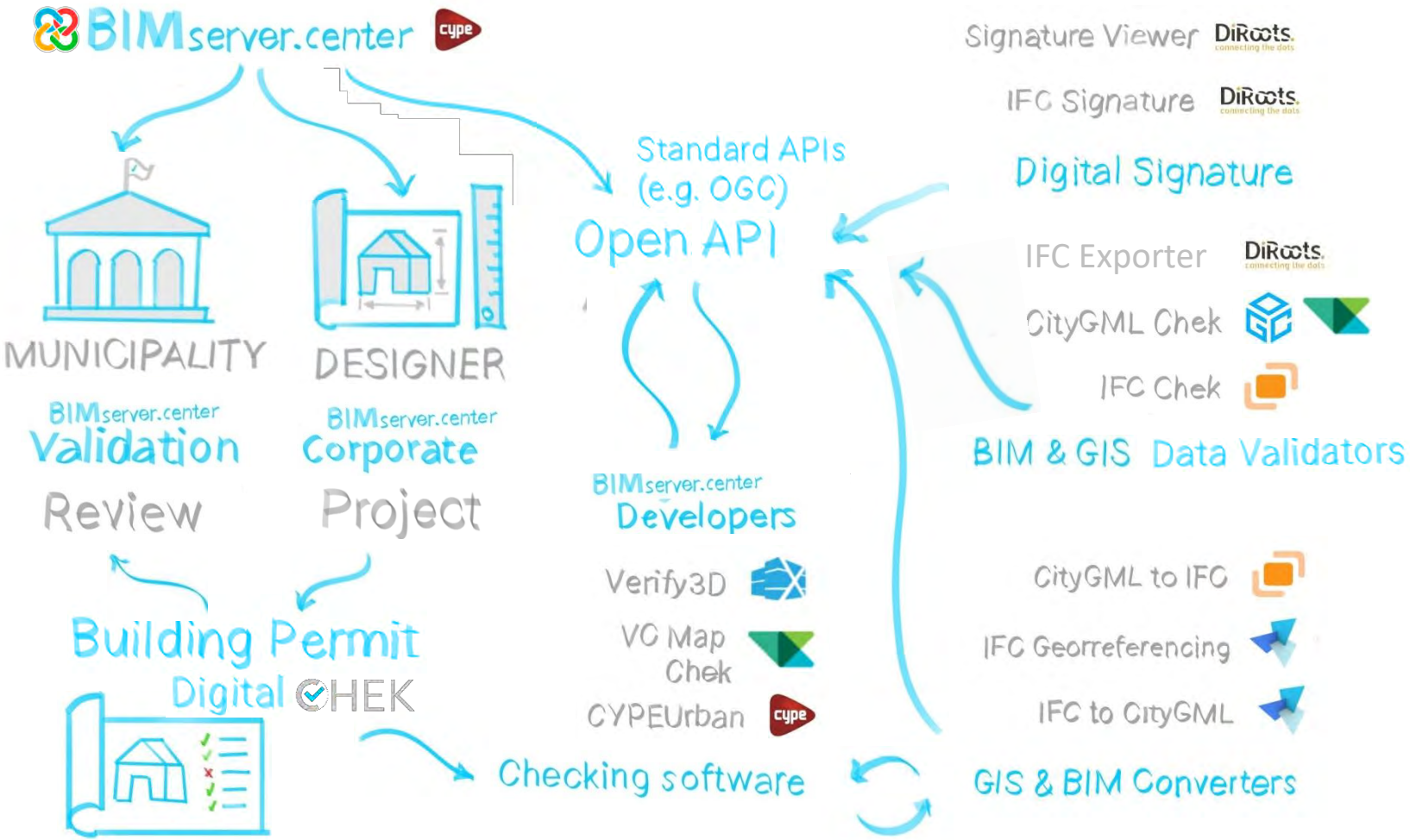

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IFC Signature
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IFC Exporter
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IFC Chek
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CityGML to IFC
IFC Georreferencing
IFC to CityGML
GIS & BIM Converters


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cype
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DiRoots
IFC Signature
DiRoots
Digital Signature
IFC Exporter
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IFC Chek
BIM & GIS Data Validators
CityGML to IFC
IFC Georreferencing
IFC to CityGML
GIS & BIM Converters

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Tools and practical examples of CHEKdbp

VC Map CHEK Plugin

CHEK Advanced Summer Course - Module 10, 11th July 2025

Funded by
the European Union

Elisa Dutsch

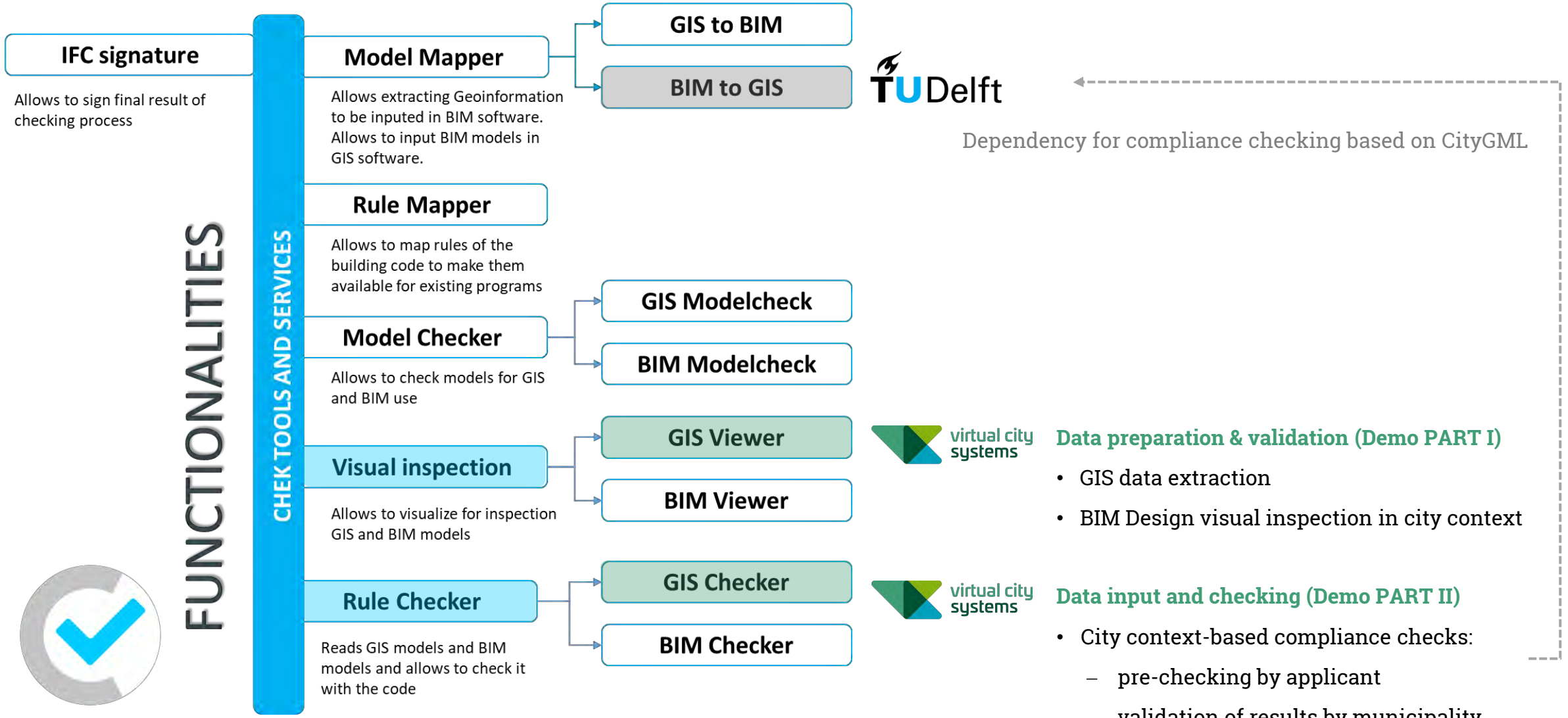
virtual city systems

VC Map CHEK plugin

VC Map is a **web-based application** where users from a wide range of technical areas can share and work on data together. By **displaying geodata in a combination of 2D, 3D, and oblique aerial views**, VC Map makes it possible to carry out a variety of **analyses and simulations**. VC Map offers **powerful extensibility via plugins**, allowing developers to enhance and customize the framework to meet specific use cases.

The **CHEK plugin** for VC Map provides custom functionality for the DBP workflow. Its main purpose is to carry out **urban planning compliance checks** on building proposals **that require the buildings geolocation and its surroundings**. This may include checking distance parameters from the building design to other buildings, traffic areas, or plot and cadastral borders; buildability indices and building heights, among others. The plugin also manages the **connection and data exchange with the DBP platform**.

CHEK Toolkit



TU Delft

Dependency for compliance checking based on CityGML

virtual city systems

Data preparation & validation (Demo PART I)

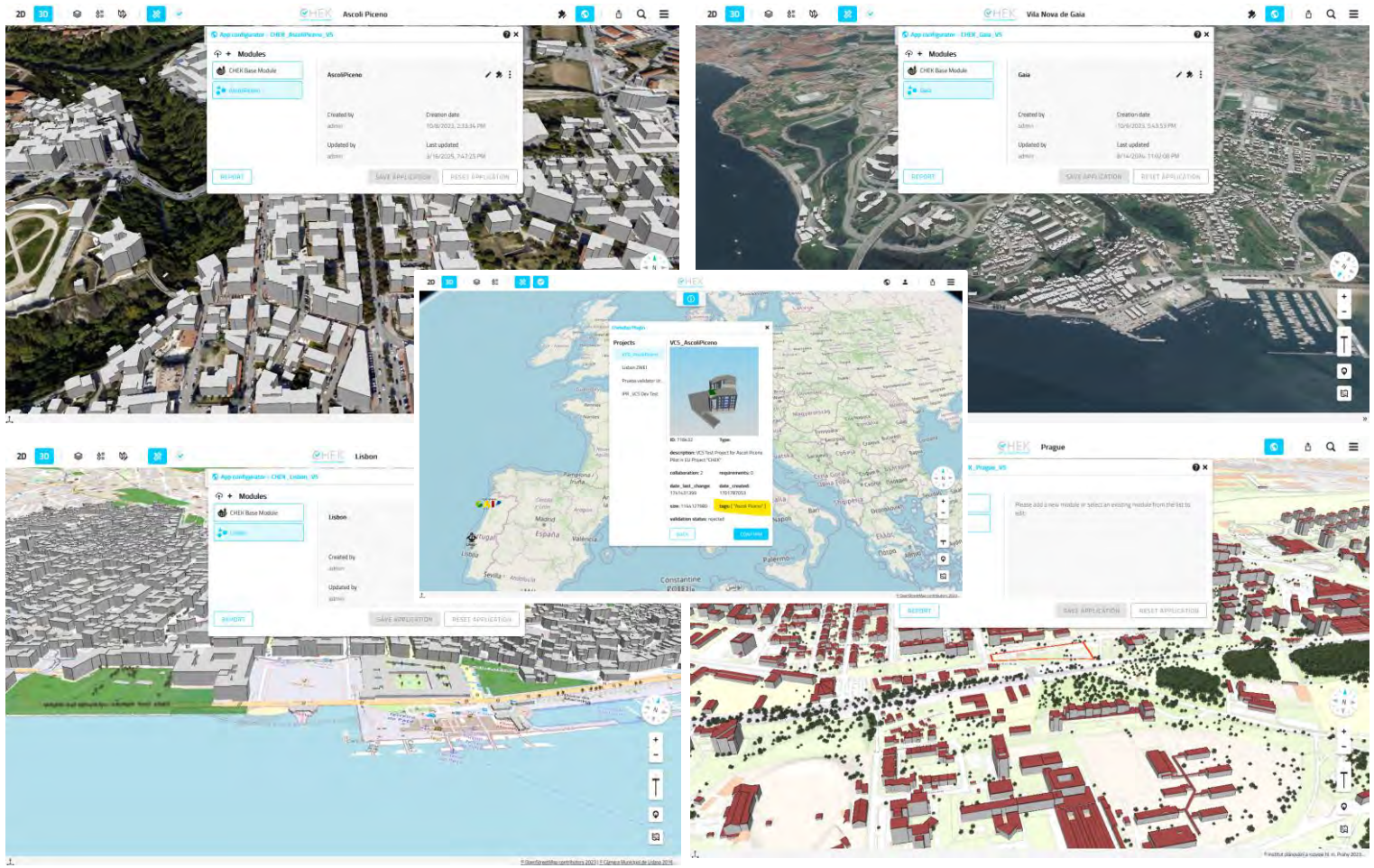
- GIS data extraction
- BIM Design visual inspection in city context

virtual city systems

Data input and checking (Demo PART II)

- City context-based compliance checks:
  - pre-checking by applicant
  - validation of results by municipality

Background: Virtual City Map

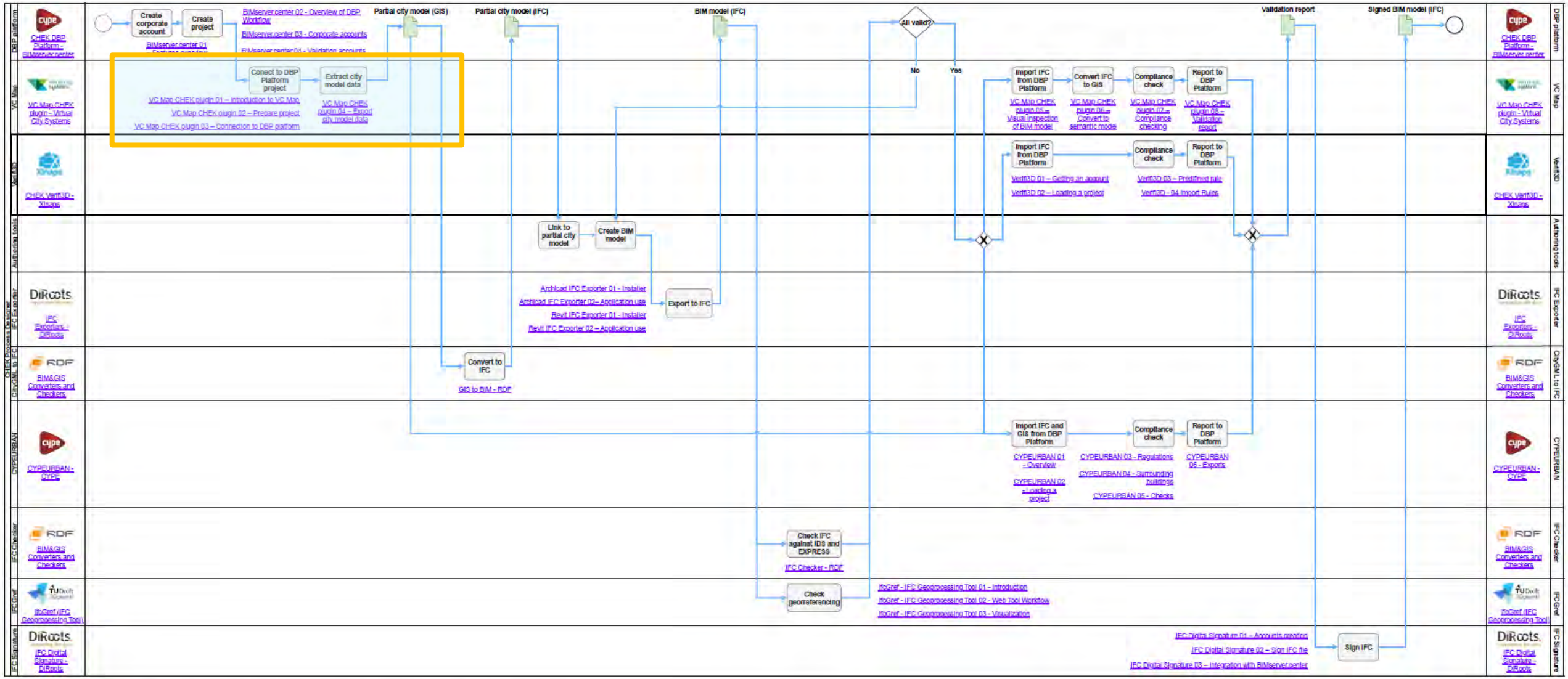


- VC Map apps are **modularized**
- Modules **complement** existing modules, and can **overwrite** individual components
- Modules are **reusable** and can be **dynamically loaded/unloaded**

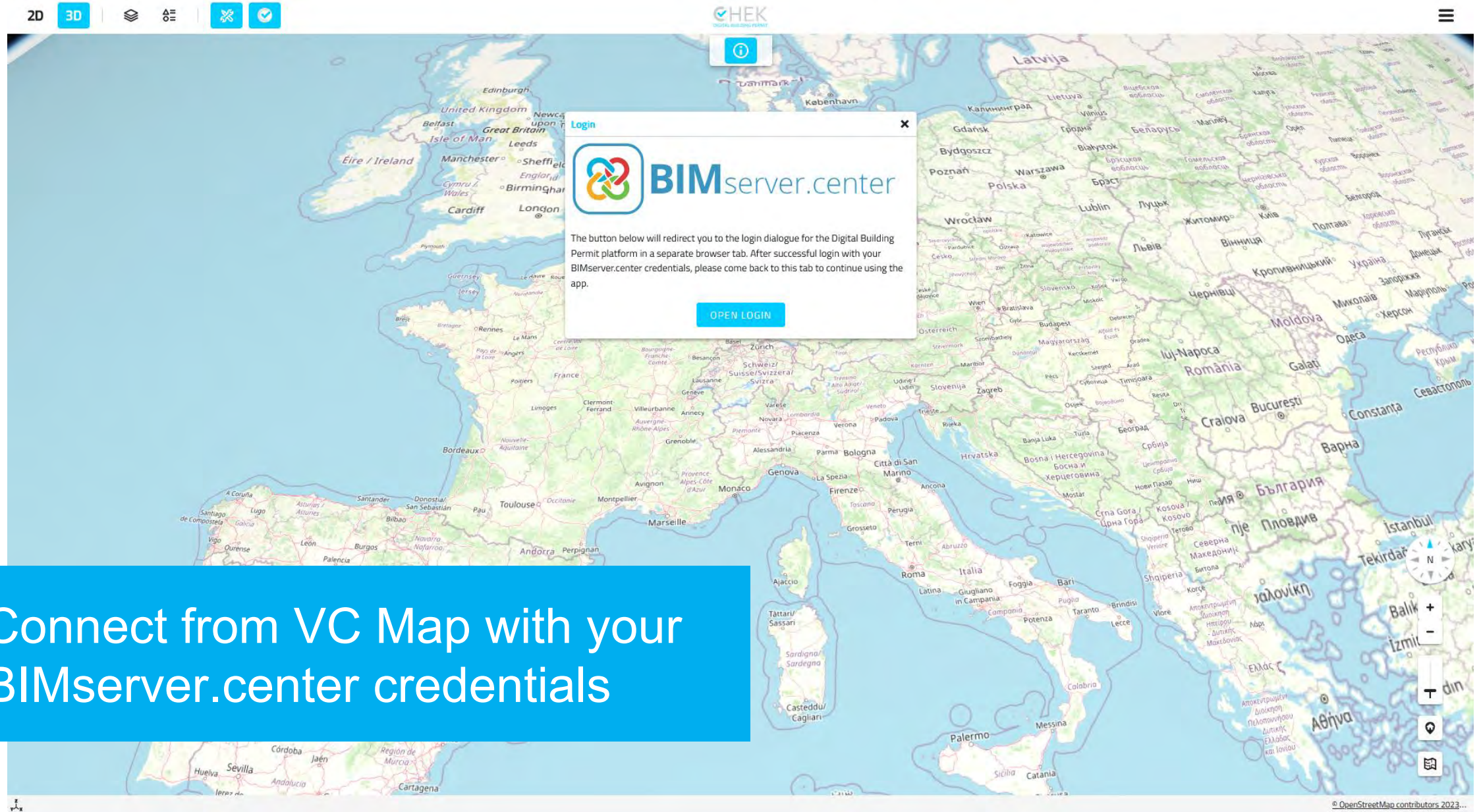
CHEK Map contains

- **Application (Base) module** containing general UI configuration and selected **plugins,** e.g. CHEK for DBP platform connection
- **Extension module** per pilot case that contain **pilot specific data** that are dynamically loaded by CHEK plugin based on the DBP context

CHEK Process Map - Designer

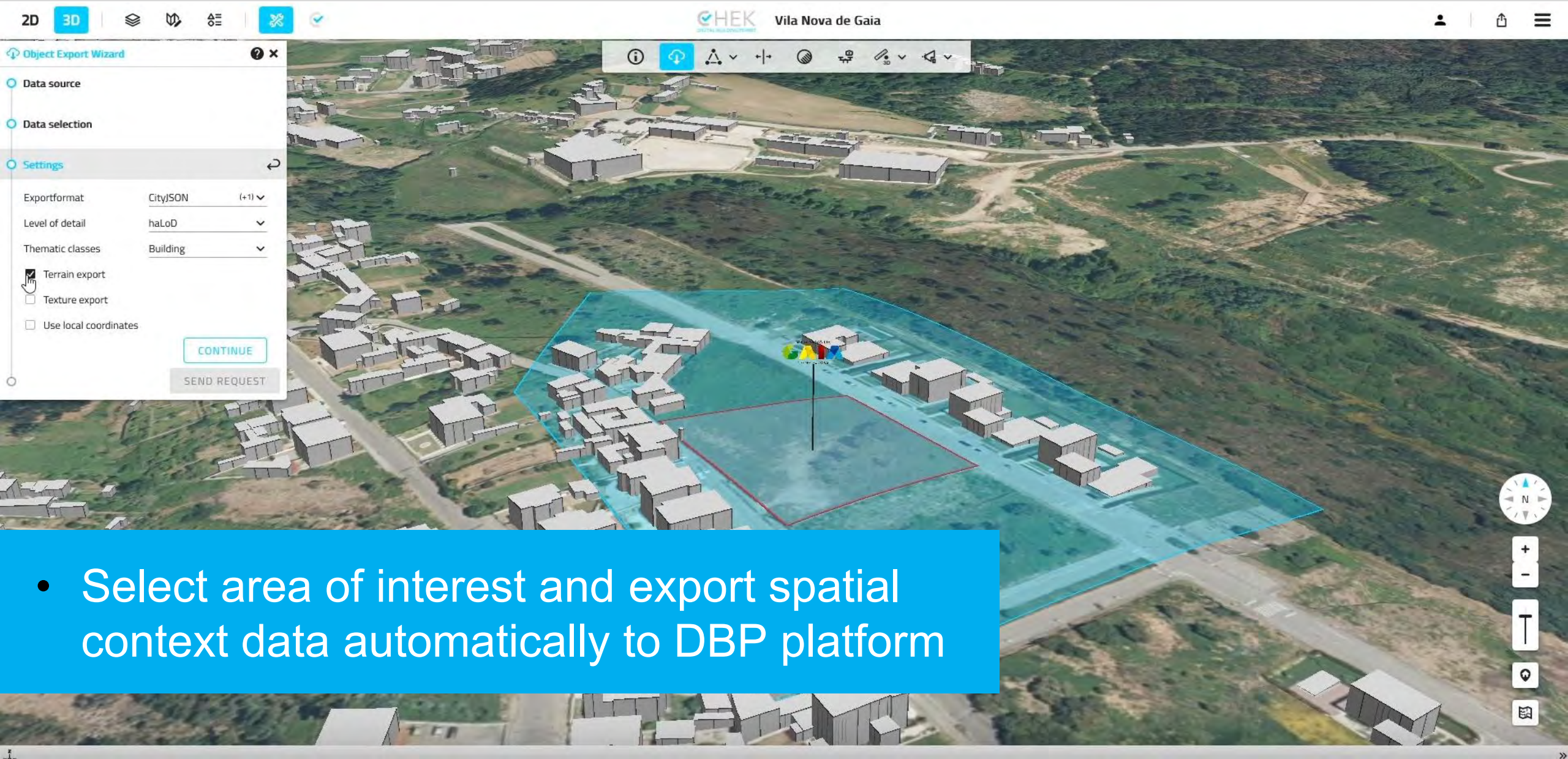


DEMO Workflow – Connection to DBP Platform



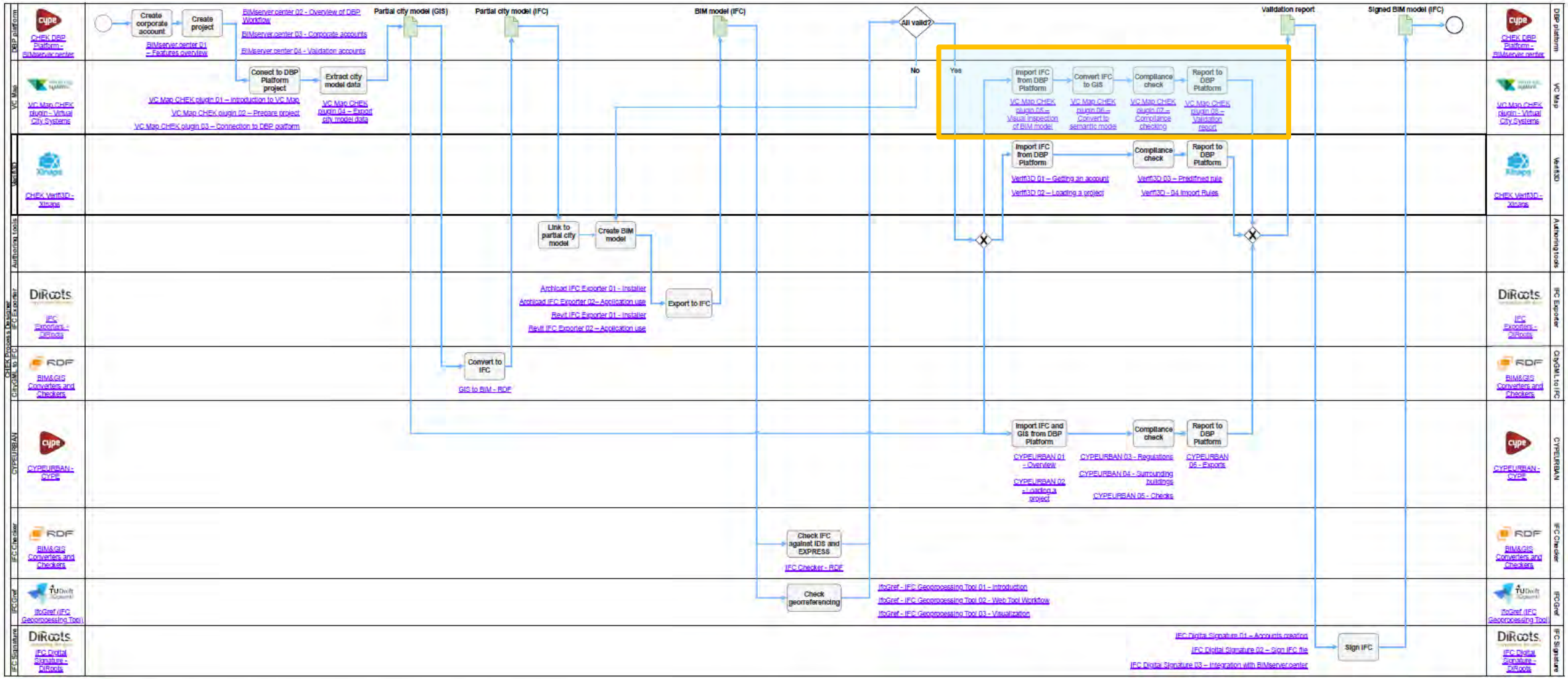
- Connect from VC Map with your BIMserver.center credentials

DEMO Workflow – Extract city model data

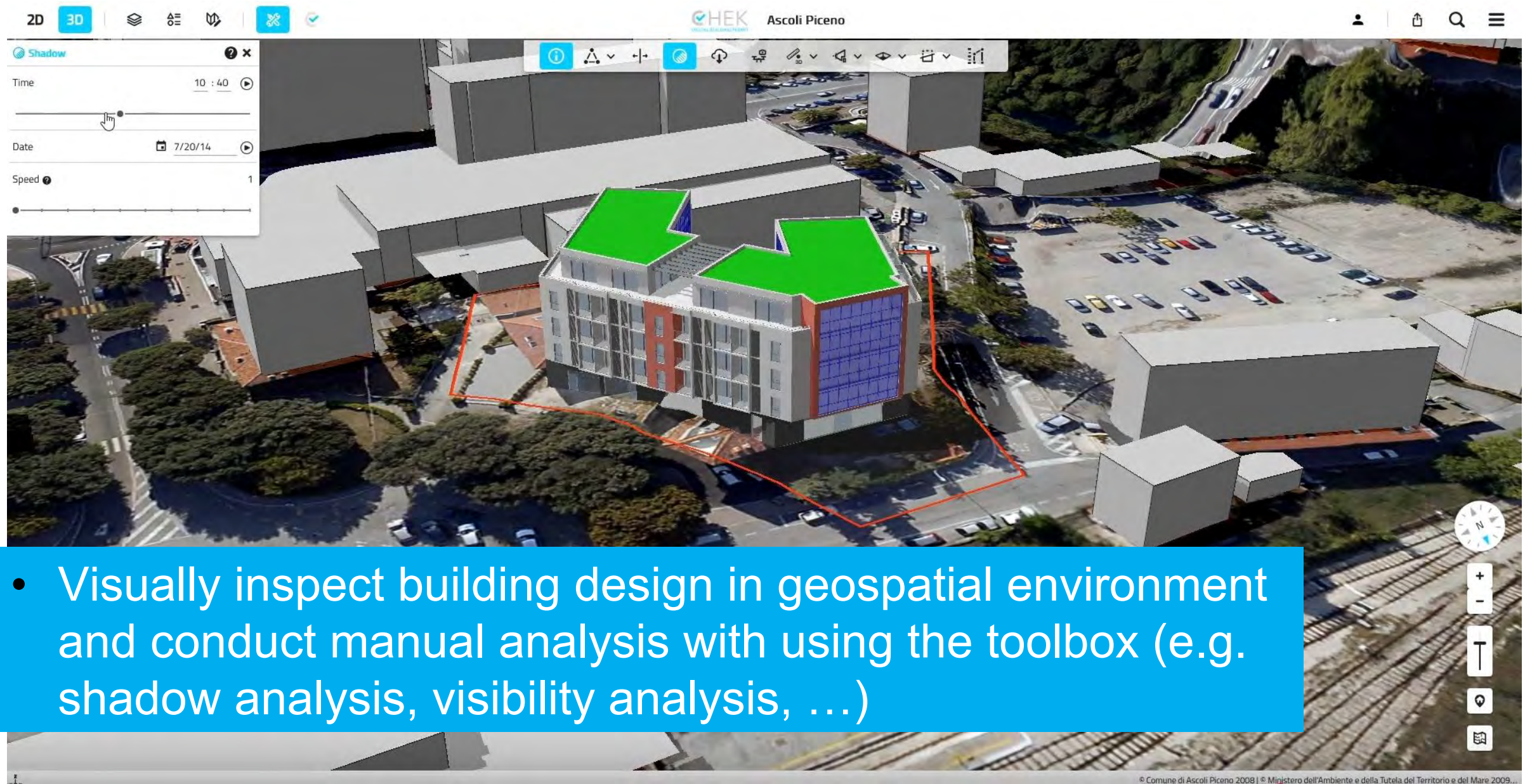


- Select area of interest and export spatial context data automatically to DBP platform

CHEK Process Map - Designer

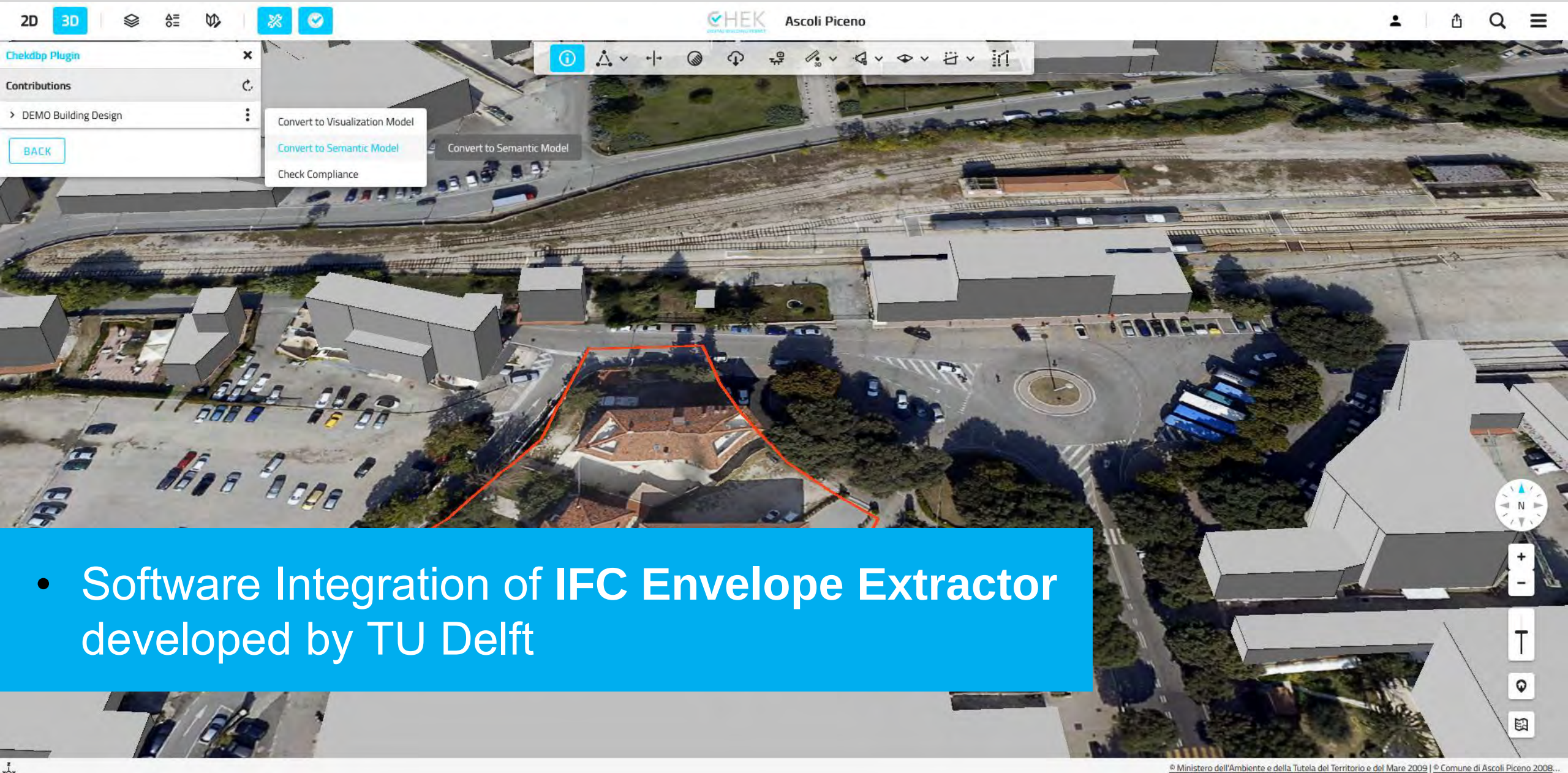


DEMO Workflow – Data integration into GIS – Visual inspection



- Visually inspect building design in geospatial environment and conduct manual analysis with using the toolbox (e.g. shadow analysis, visibility analysis, …)

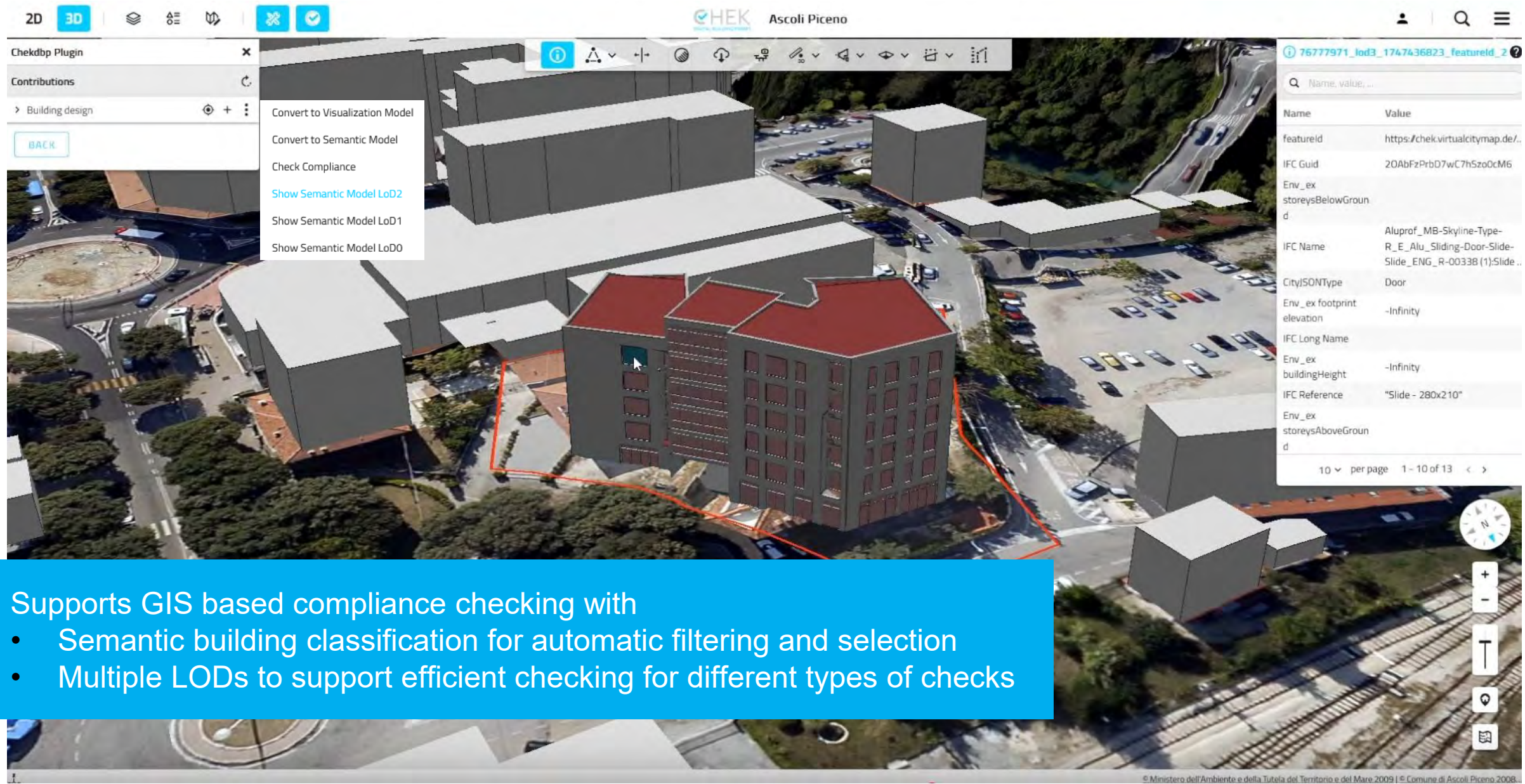
DEMO Workflow – Data integration into GIS – Semantic model



- Software Integration of **IFC Envelope Extractor** developed by TU Delft

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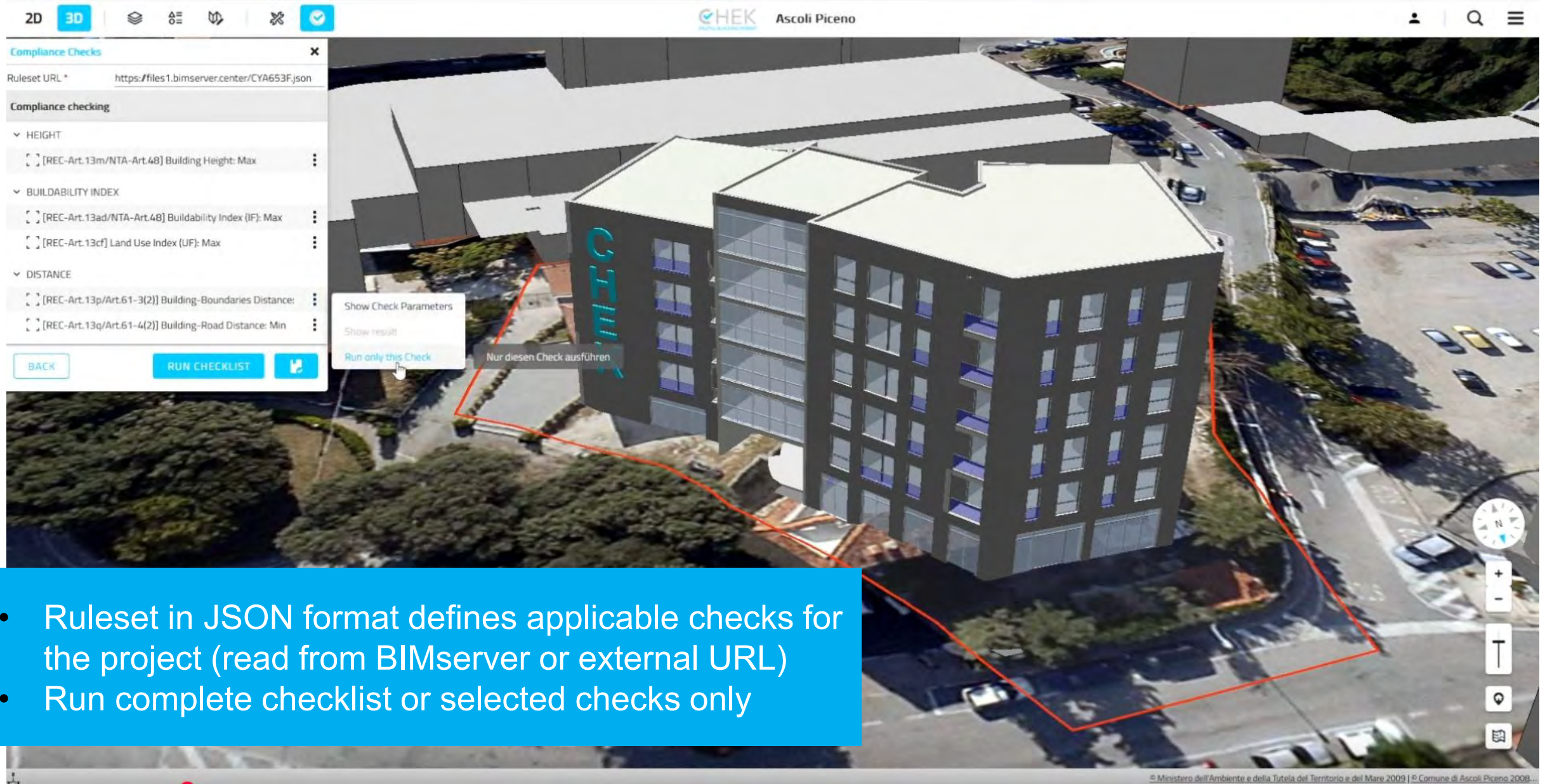
DEMO Workflow – Data integration into GIS – Semantic model



Supports GIS based compliance checking with

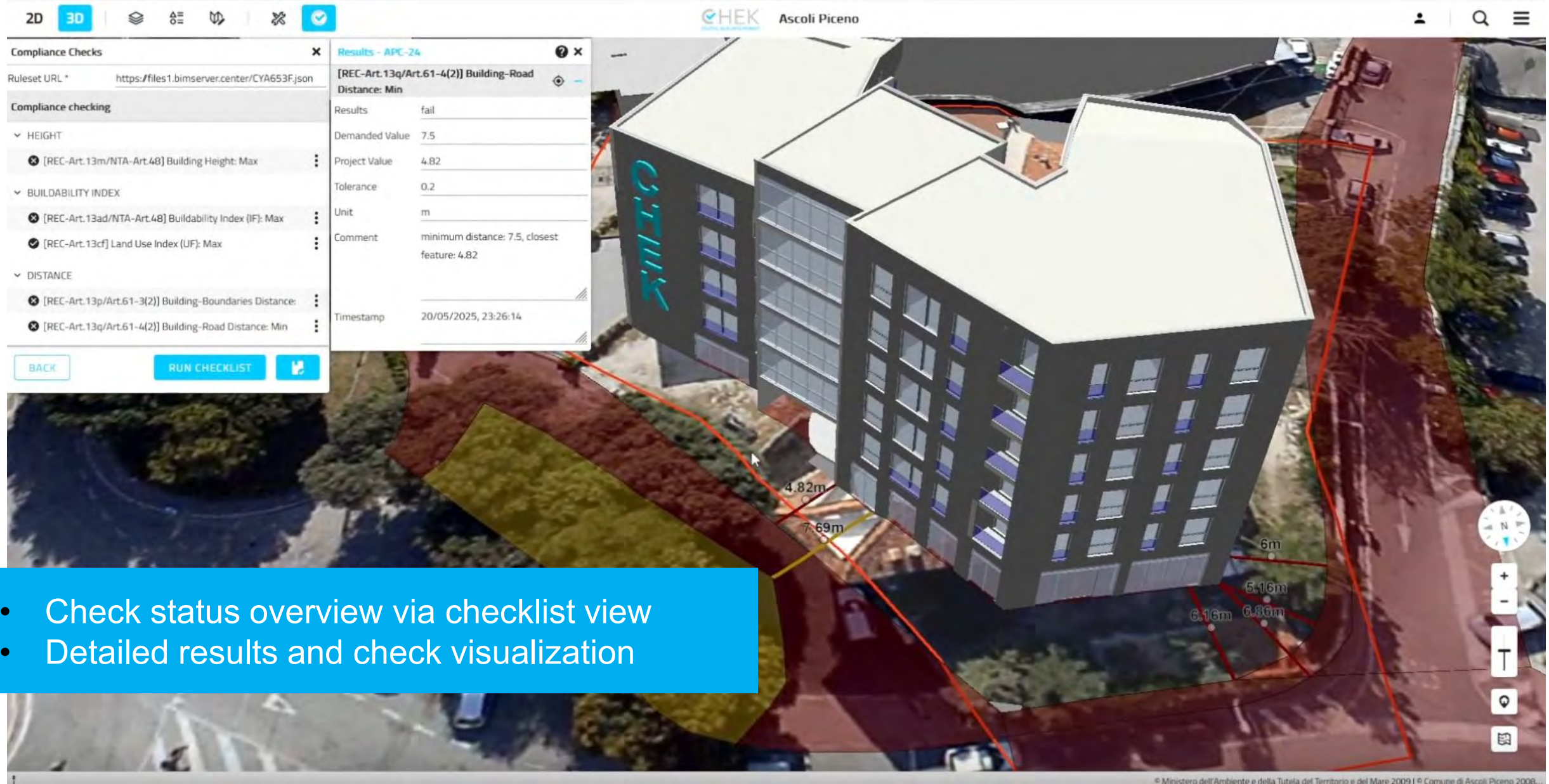
- Semantic building classification for automatic filtering and selection
- Multiple LODs to support efficient checking for different types of checks

DEMO Workflow – Compliance checking



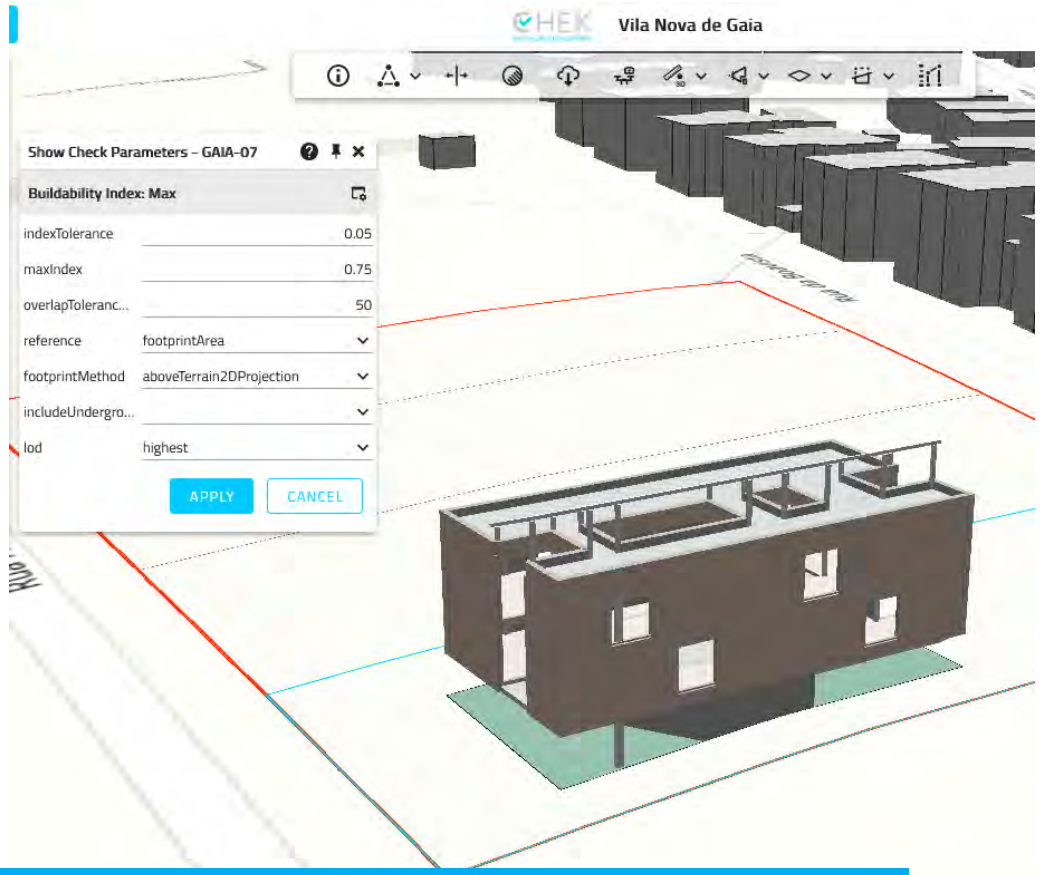
- Ruleset in JSON format defines applicable checks for the project (read from BIMserver or external URL)
- Run complete checklist or selected checks only

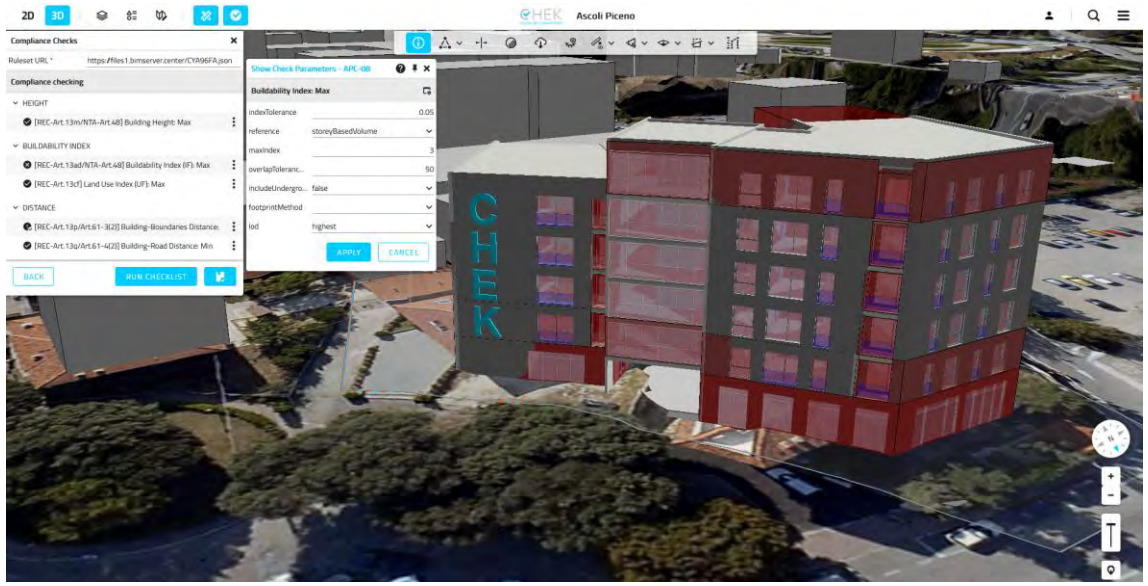
DEMO Workflow – Compliance checking

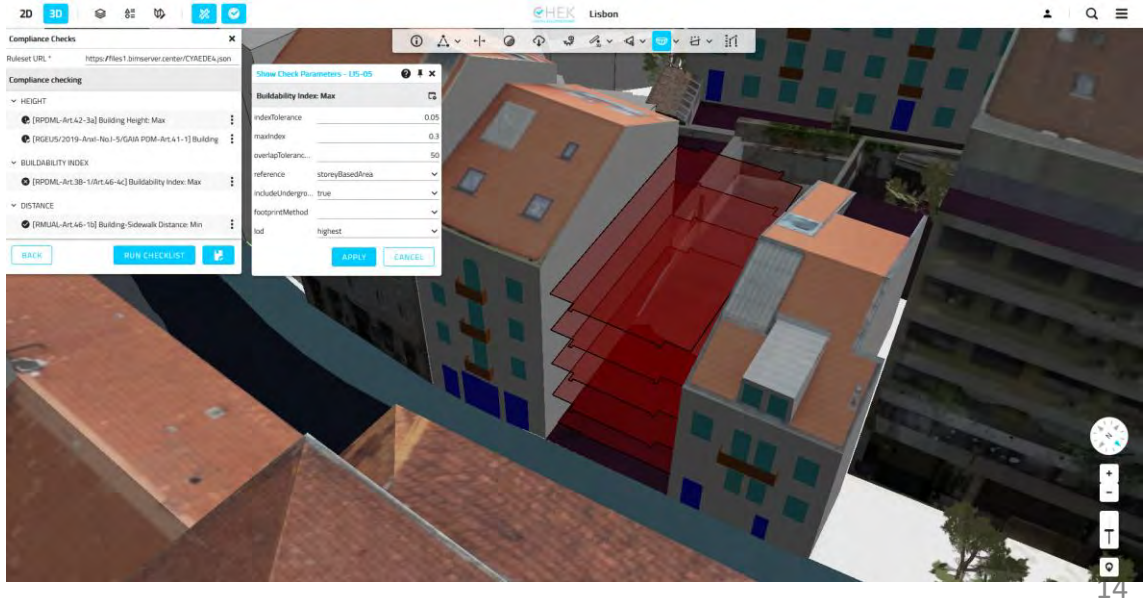


- Check status overview via checklist view
- Detailed results and check visualization

DEMO Workflow – Compliance check configuration

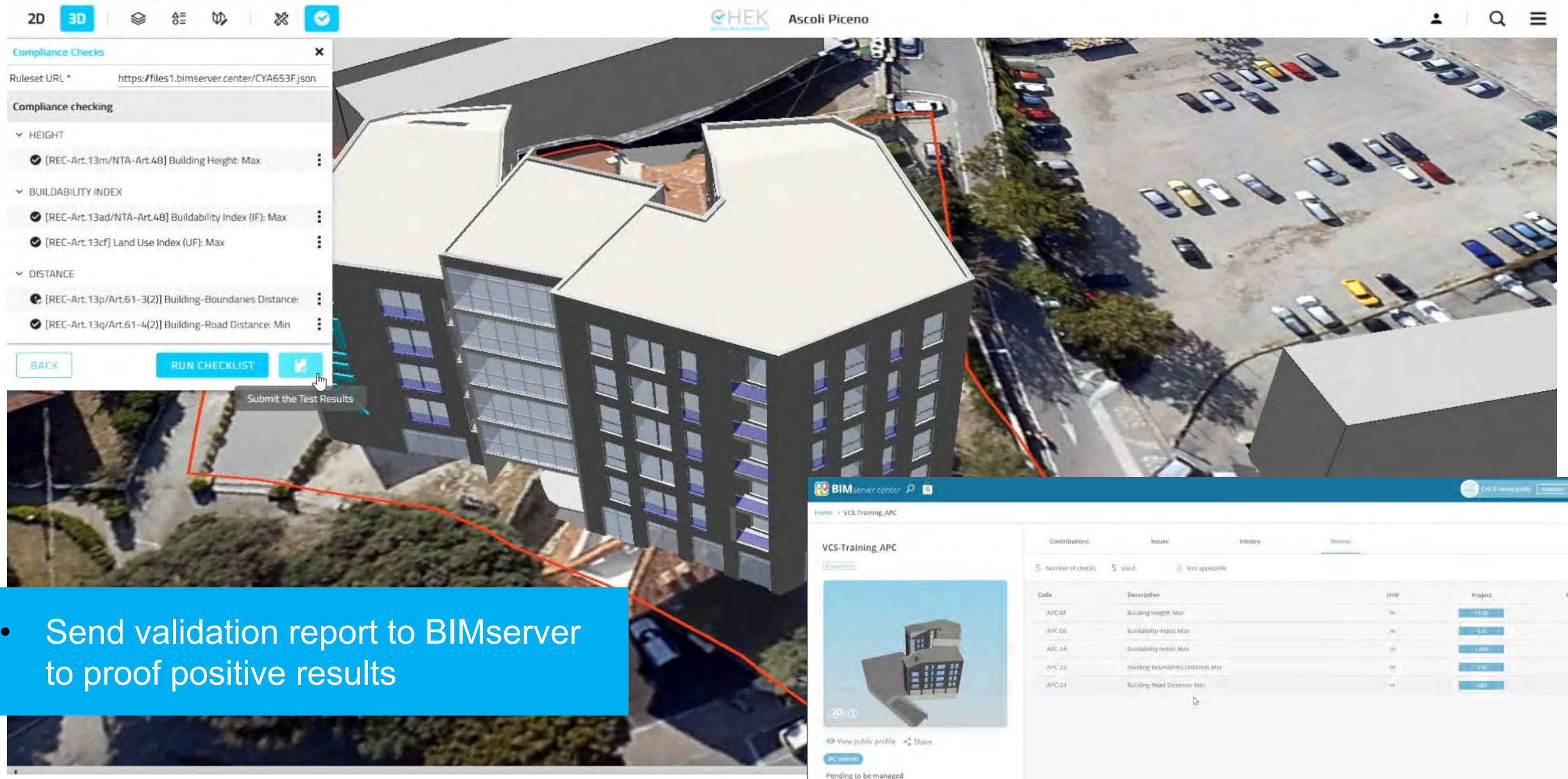






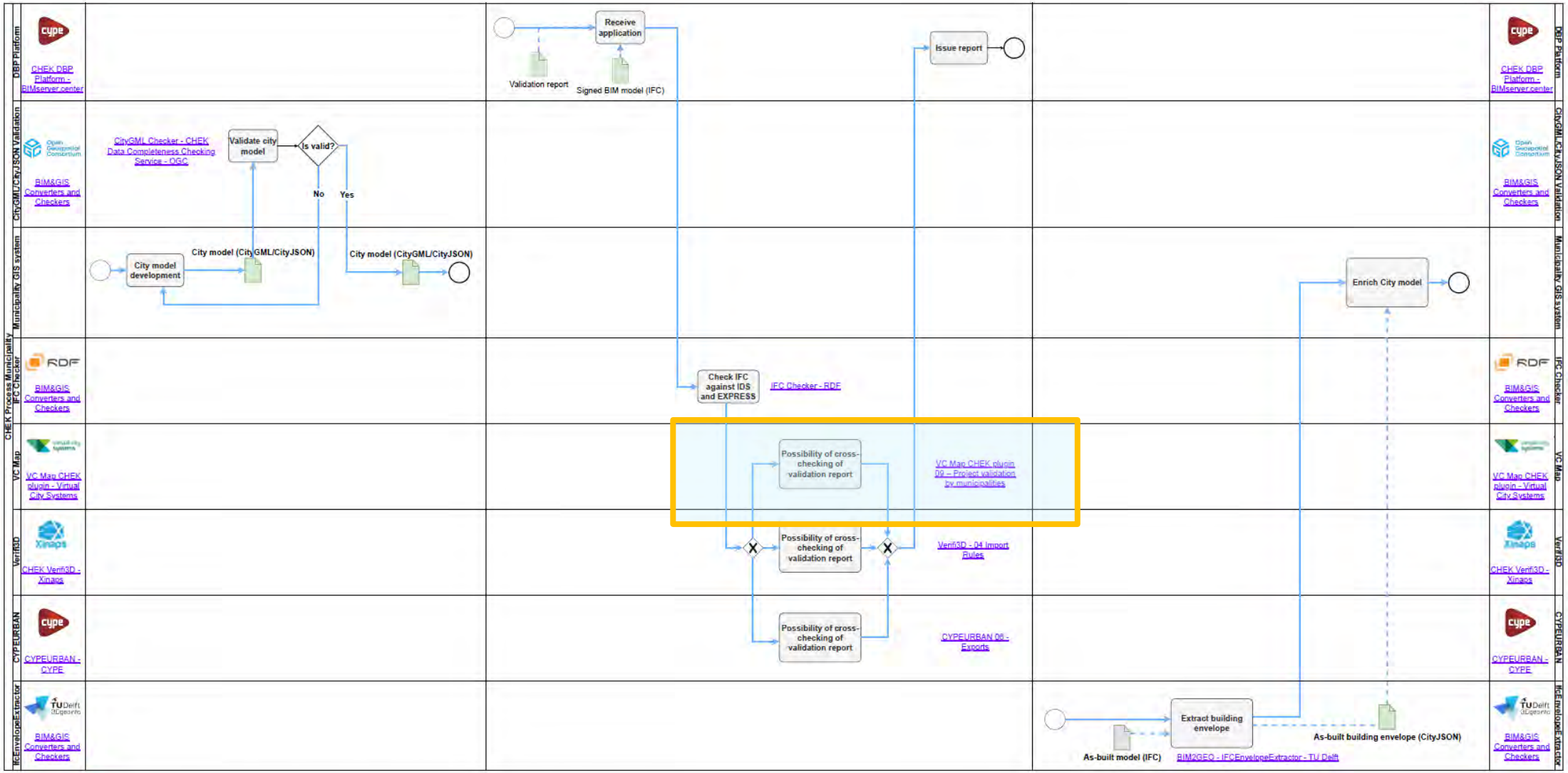
- Customizable checks and full automation through parameterized check configuration

DEMO Workflow – Validation report

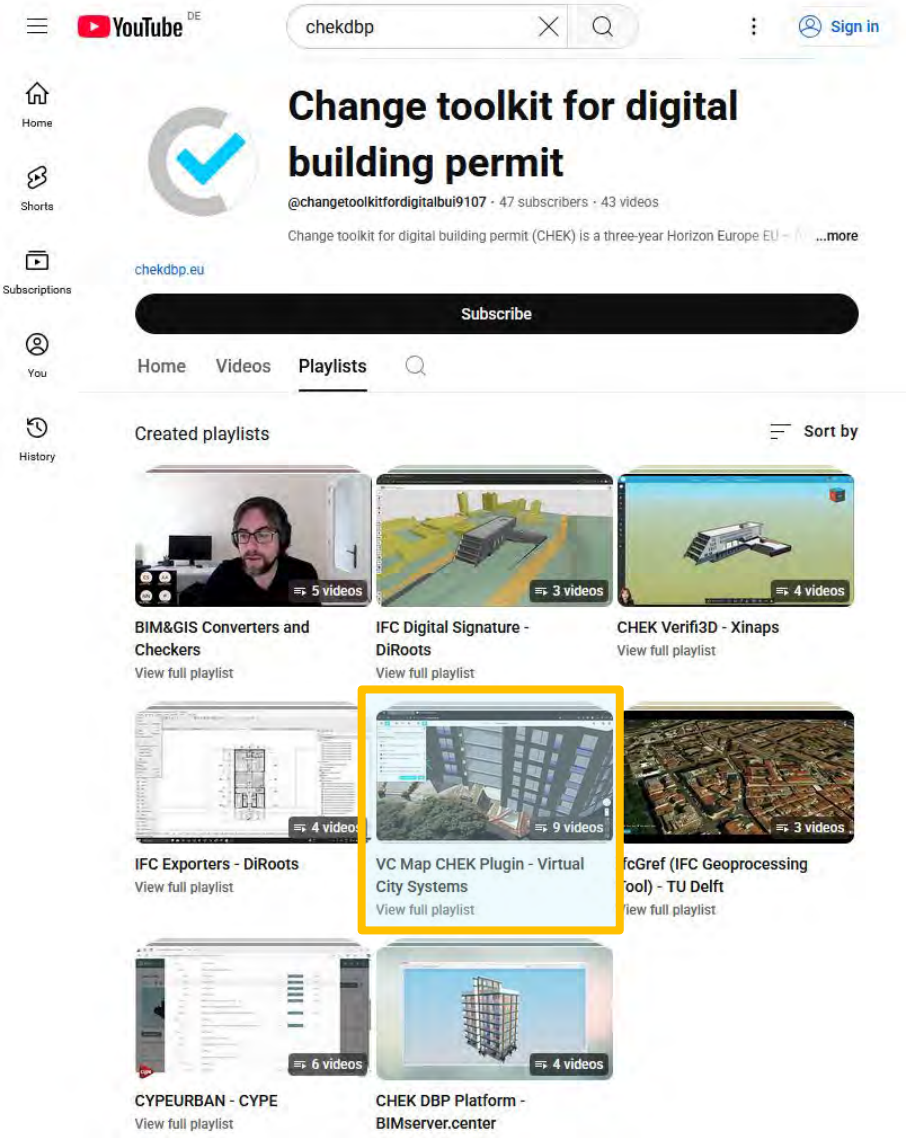


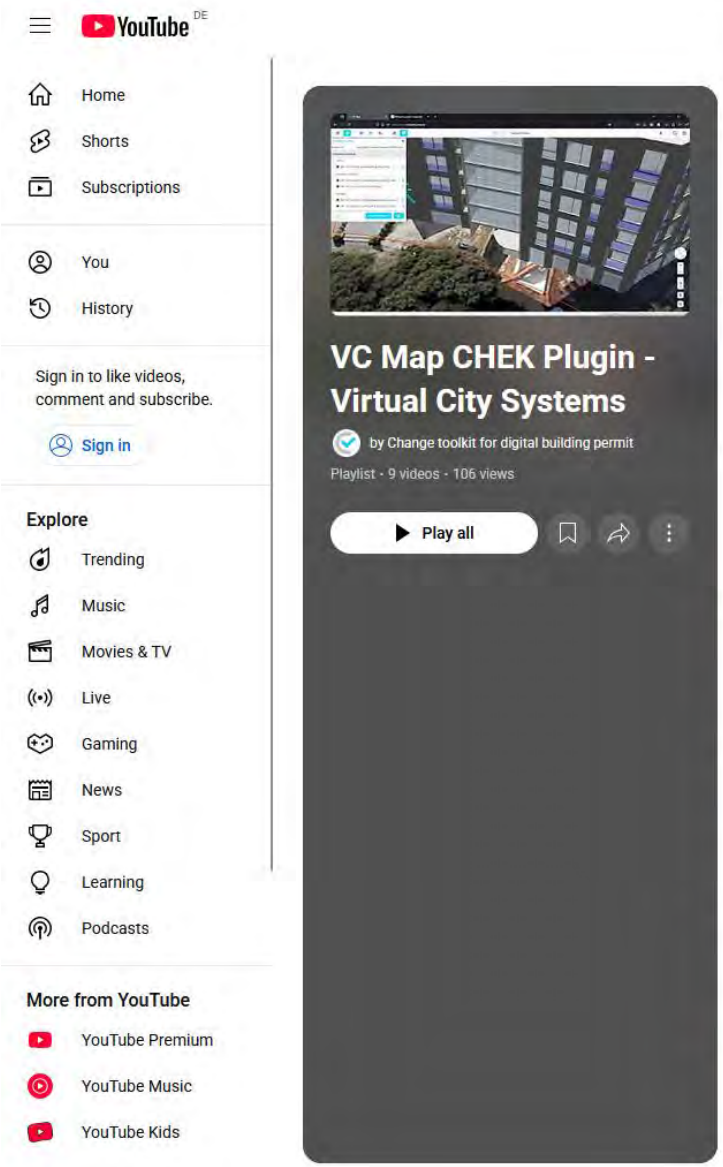
- Send validation report to BIMserver to proof positive results

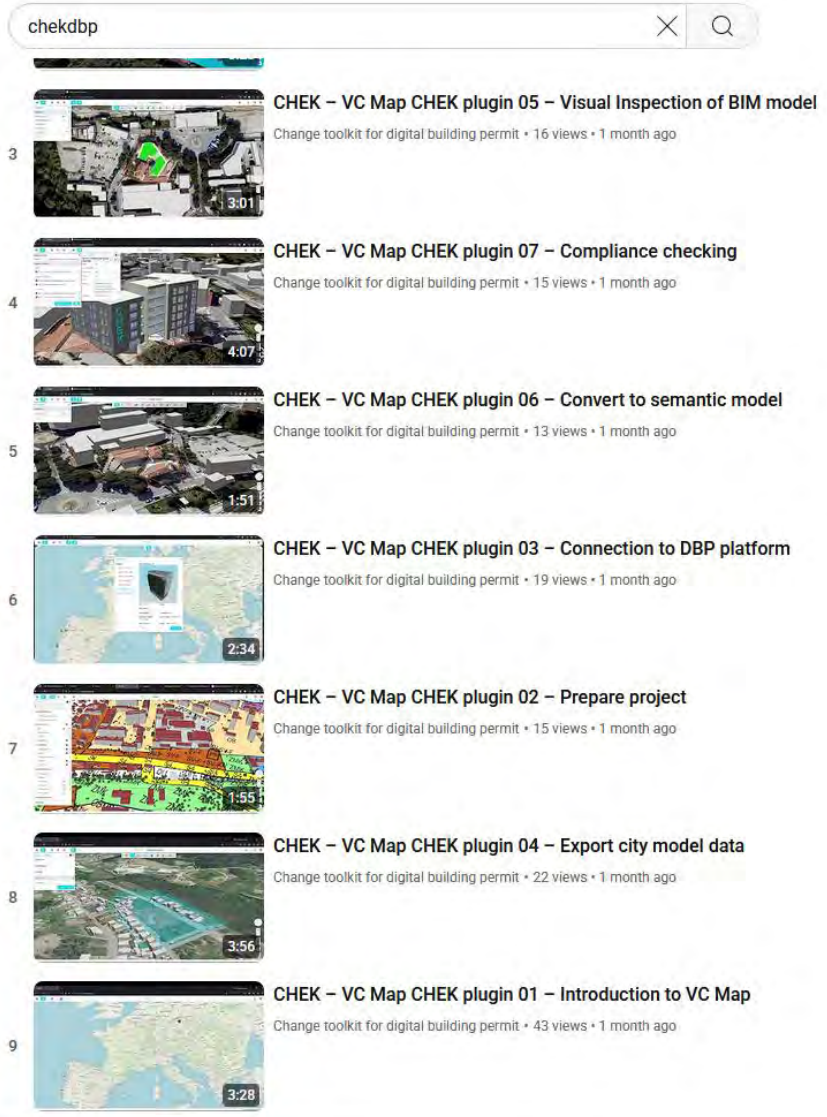
CHEK Process Map - Municipality



CHEK YouTube channel – Playlist: VC Map CHEK Plugin







Challenges and conclusions from CHEK

- GIS-based compliance checking results heavily **depend on pipeline of good modelling practices and data conversion** – still comes with challenges
- GIS-based checking **requires city models of high geometric accuracy** and often higher levels of detail than currently available to some municipalities to lead to relevant results
- **Regulations might need to adapt to modern checking workflows** to better support machine readable formats and implementation of automated compliance checks
- **Standardization of zoning plans** would boost development to support automatic extraction of applicable regulations and constraint values

Ask and Discover: Your Questions, Our Answers

Thank you very much for your attention!



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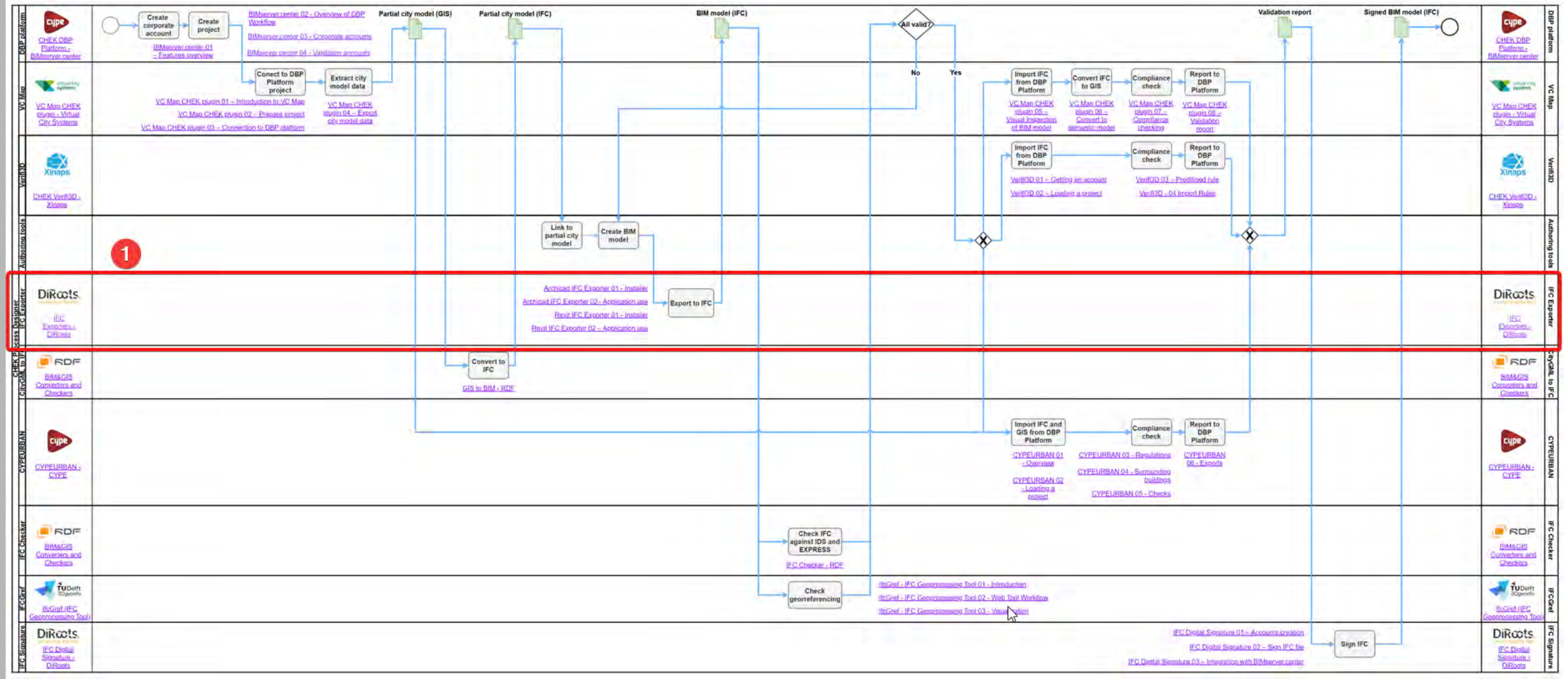
IFC EXPORTER

July 2025

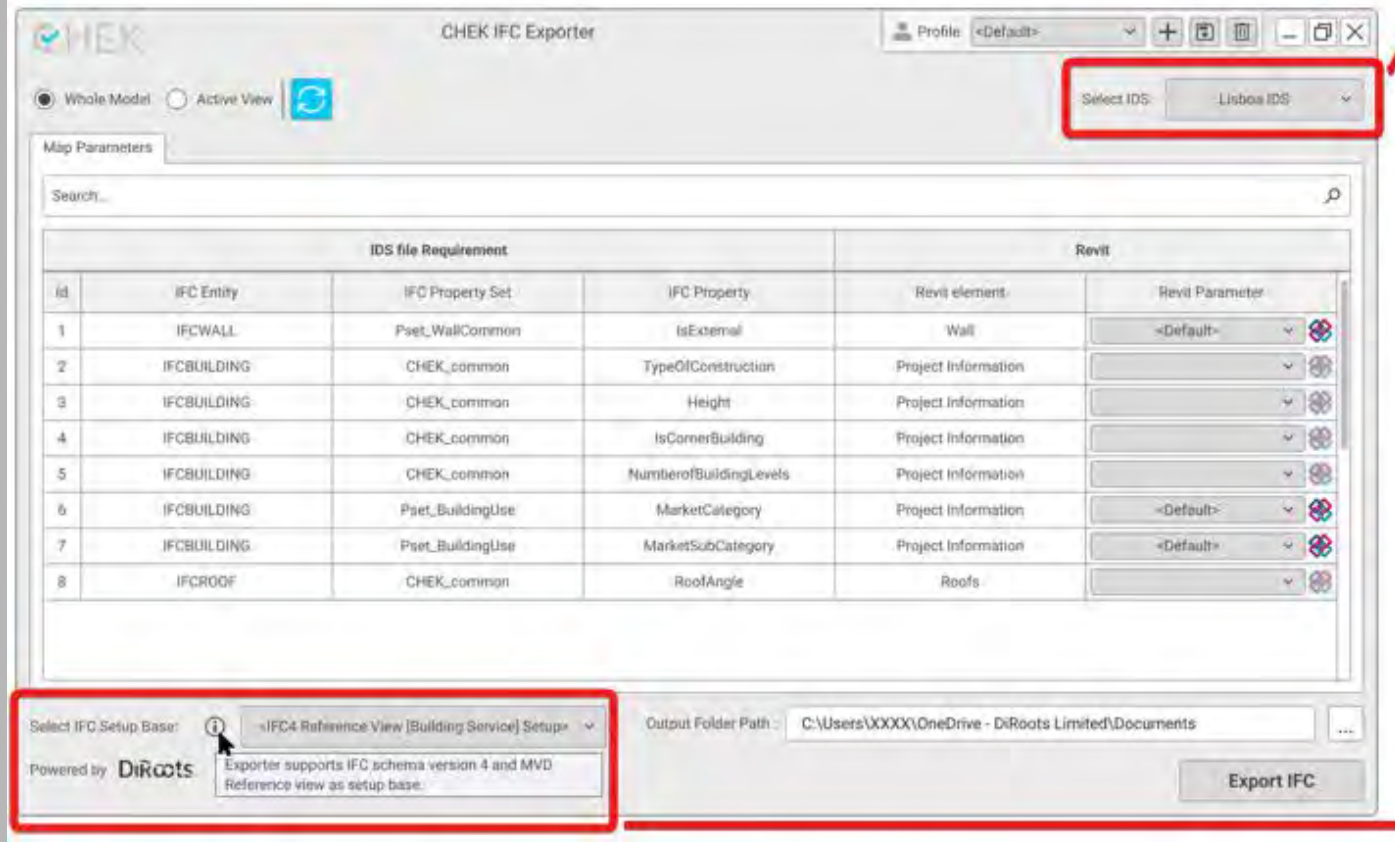
DiRoots.

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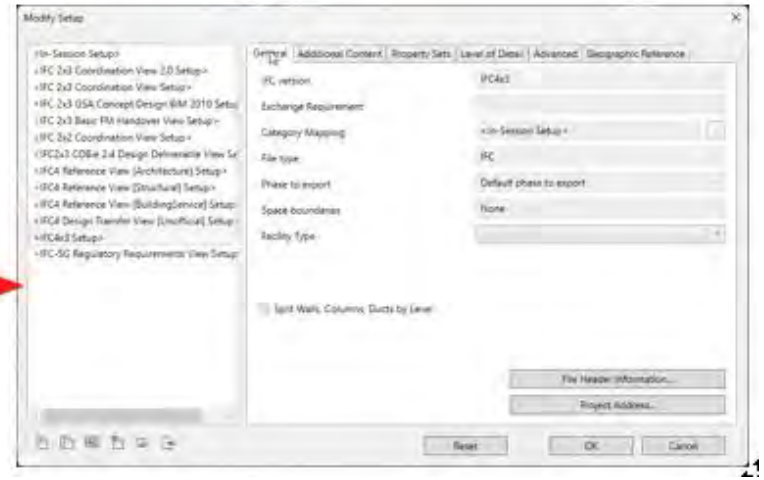
Designer Workflow



- Software that integrates of IDS requirements for the IFC exports within BIM authoring software.
- Mapping the Properties & Custom Properties Mapping







CHEK

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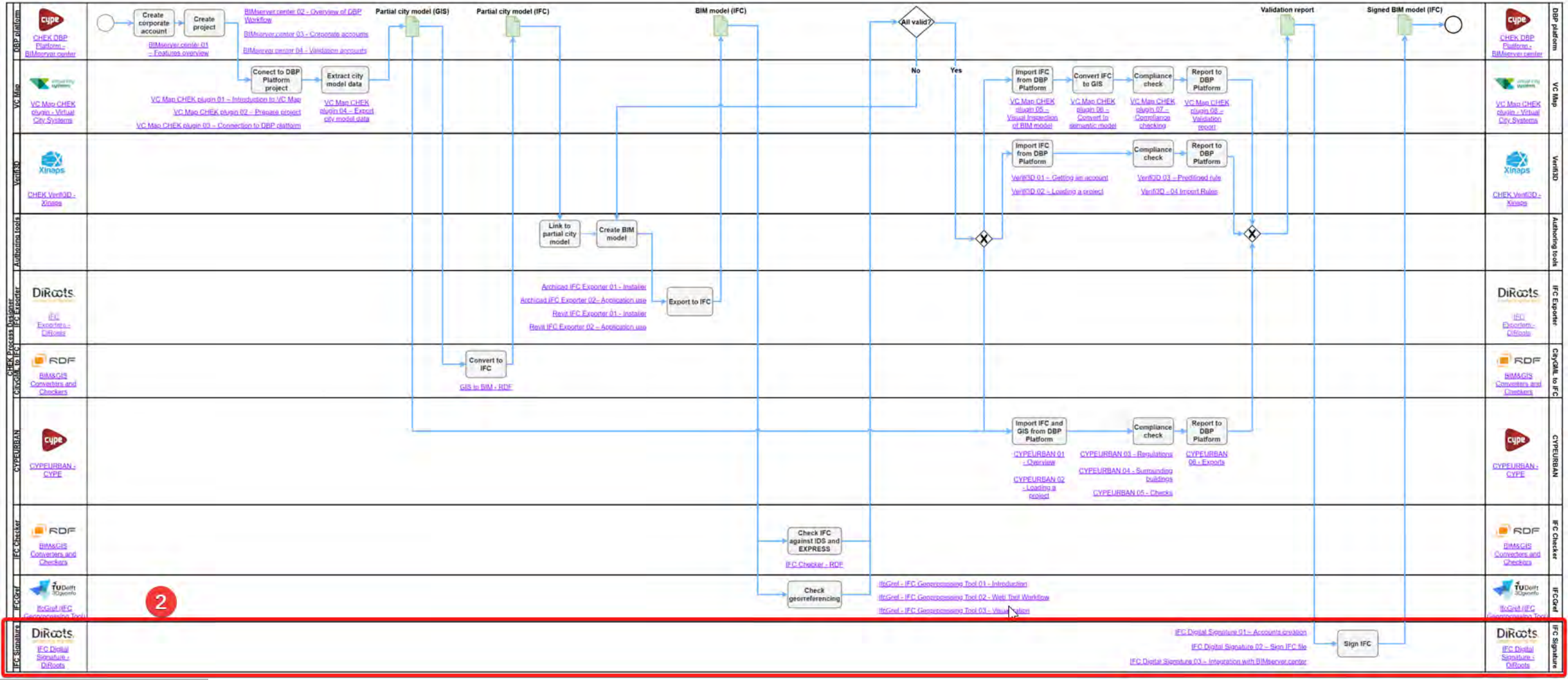
IFC DIGITAL SIGNATURE

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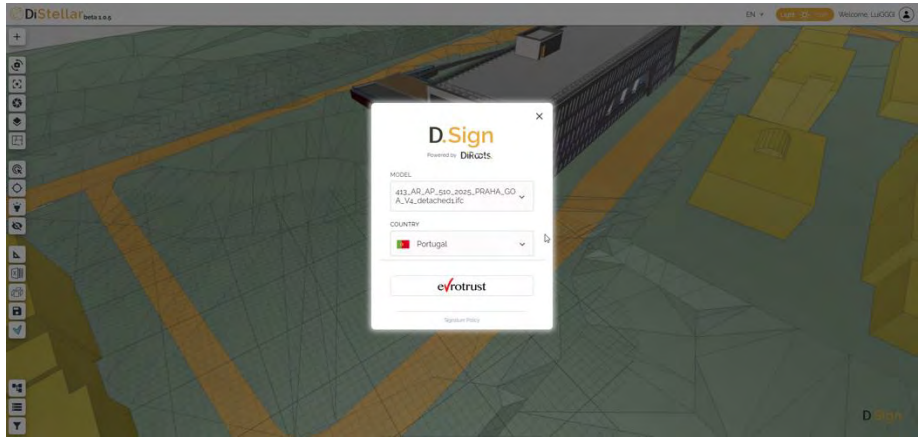
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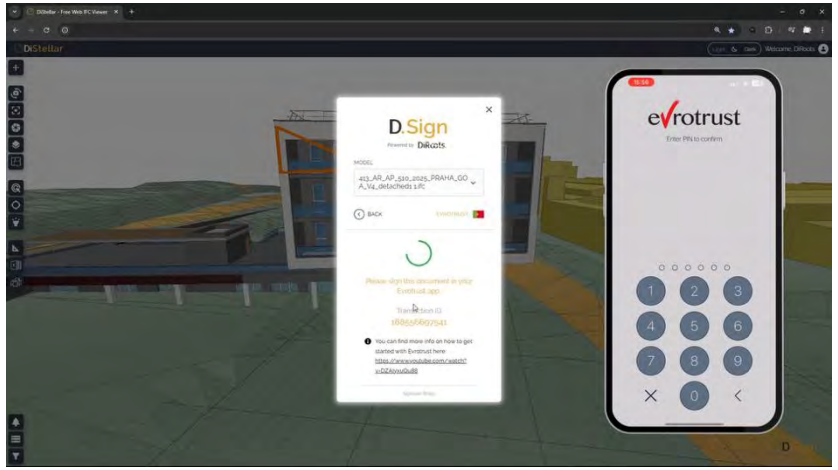
Designer Workflow

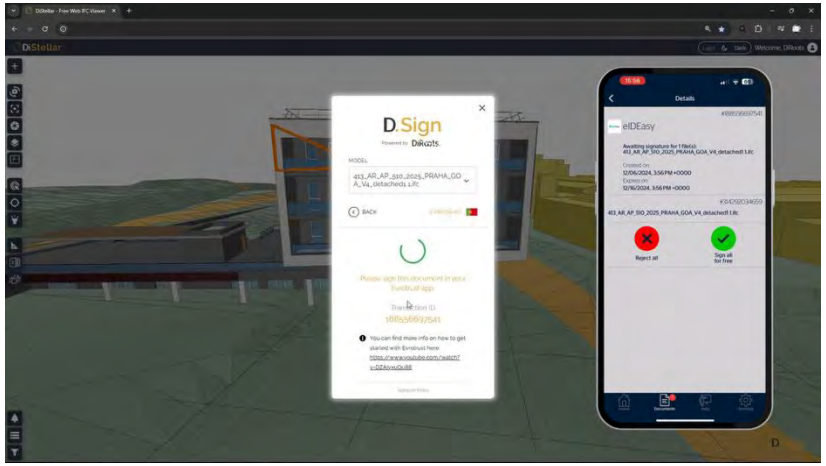


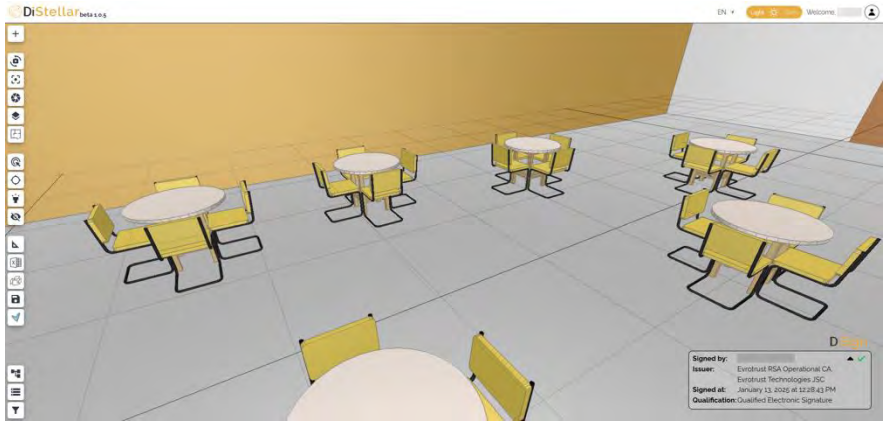
1. Digital Signature
1.1 Signature workflow
1.2 Validation workflow

- Qualified Electronic Signatures (QES) are the highest standard of digital signatures under the eIDAS Regulation.
- eIDAS regulation ensures that **electronic signatures are legally recognized, secure, and traceable** to verified individuals, enabling digital workflows to replace traditional paper-based processes with **full legal equivalence**
- Qualified certificates issued by Trusted Service Providers (TSPs). TSPs are entities officially recognized to issue certificates and digital identity services.









Feedback

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Mode: Anonymous

How satisfied are you with the modules provided?

1 - Not satisfied

10 - Extremely satisfied

M1 - Introduction and State of the Art on Building Permits *
○ (1) ○ (2) ○ (3) ○ (4) ○ (5) ○ (6) ○ (7) ○ (8) ○ (9) ○ (10)

M2 - BIM standardization *
○ (1) ○ (2) ○ (3) ○ (4) ○ (5) ○ (6) ○ (7) ○ (8) ○ (9) ○ (10)

M3 - Interoperability, openBIM and IFC *
○ (1) ○ (2) ○ (3) ○ (4) ○ (5) ○ (6) ○ (7) ○ (8) ○ (9) ○ (10)

M4 - Interoperability beyond IFC *
○ (1) ○ (2) ○ (3) ○ (4) ○ (5) ○ (6) ○ (7) ○ (8) ○ (9) ○ (10)

M5 - 3D city modelling: background and standards *
○ (1) ○ (2) ○ (3) ○ (4) ○ (5) ○ (6) ○ (7) ○ (8) ○ (9) ○ (10)

M6 - Creation of 3D city models and GeoBIM integration *
○ (1) ○ (2) ○ (3) ○ (4) ○ (5) ○ (6) ○ (7) ○ (8) ○ (9) ○ (10)

M7 - Building Permits Law *
○ (1) ○ (2) ○ (3) ○ (4) ○ (5) ○ (6) ○ (7) ○ (8) ○ (9) ○ (10)

M8 - Interpretation of Regulations: workshop *
○ (1) ○ (2) ○ (3) ○ (4) ○ (5) ○ (6) ○ (7) ○ (8) ○ (9) ○ (10)

M9 - Integration of CHEK DBP Process and Digital Technologies for DBP Automation *
○ (1) ○ (2) ○ (3) ○ (4) ○ (5) ○ (6) ○ (7) ○ (8) ○ (9) ○ (10)

M10 - Tools and practical examples of CHEK DBP *
○ (1) ○ (2) ○ (3) ○ (4) ○ (5) ○ (6) ○ (7) ○ (8) ○ (9) ○ (10)

Do you believe the CHEK toolkit offers solutions to the issues faced in implementing Digital Building Permits? Also feel free to provide any additional comments about the CHEK course/project. *

Required

Continue