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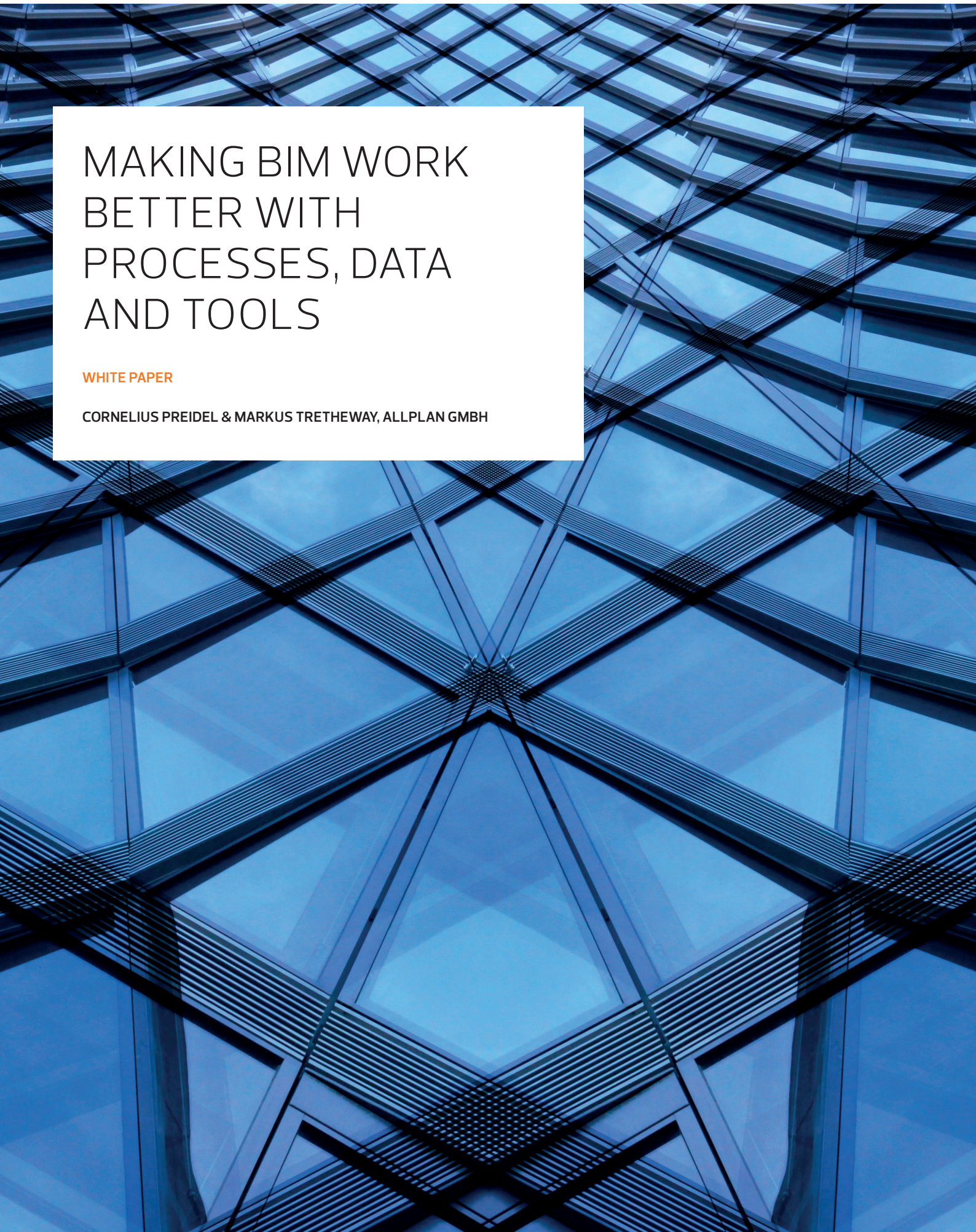

MAKING BIM WORK BETTER WITH PROCESSES, DATA AND TOOLS

WHITE PAPER

CORNELIUS PREIDEL & MARKUS TRETHEWAY, ALLPLAN GMBH

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C. PREIDEL & M. TRETHEWAY; ALLPLAN GMBH, GERMANY

Building Information Modeling (BIM) is the digital response to the question how the information relating to a construction project can always be up-to-date for all parties concerned, thus avoiding any collisions and inconsistencies. As a technological basis for the BIM working method there is what is known as a Common Data Environment (CDE) – a central data management environment in which all information for a construction project is gathered, managed, evaluated and shared. Smooth interoperability between the CDE and the many different programs used in the construction process is still proving problematic however. In order to resolve this interoperability issue the BIM Integration Framework (BIF) was, therefore, developed. This creates a link between CDE and BIM tools and also offers the possibility of connecting even non-BIM-based programs to the CDE.

INTRODUCTION

With the development of digital methods for civil engineering, such as in particular Building Information Modeling (BIM), the collaborative processes have increasingly also come to the fore. A major part of the technological change in the construction sector is in the development of the model-based working method, or workflow, which has a significant impact on the collaboration of the project participants. The digital models used in this working method not only contain three-dimensional geometric content but are also supplemented with semantic information. The individual parties involved in a construction project create, modify or expand these models during project handling and, in this way, create a comprehensive digital picture of the product. The error-free exchange and the smooth processing of such information constitute a key challenge for the building and construction industry. At the same time, many of the current work and communication processes can be improved considerably with the aid of these digital, structured building models. In order to be able to provide a reliable basis for these processes, technical solutions have to be developed. One such solution comes in the form of the Common Data Environment (CDE) – a data management tool in which all information pertaining to a construction project is brought together. Below we shall first introduce the fundamental concept of the CDE. Then a software solution will be shown which enables the linking of a range of BIM-enabled software products to such a data platform for stakeholders from various disciplines: the BIM Integration Framework.

- **Many work and communication processes in building and construction can be improved considerably with the aid of digital, structured building models.**
- **The error-free exchange and the smooth processing of digital information constitute a key challenge for building and construction.**
- **The Common Data Environment (CDE) serves as central data management tool, in which all information pertaining to a construction project is brought together.**

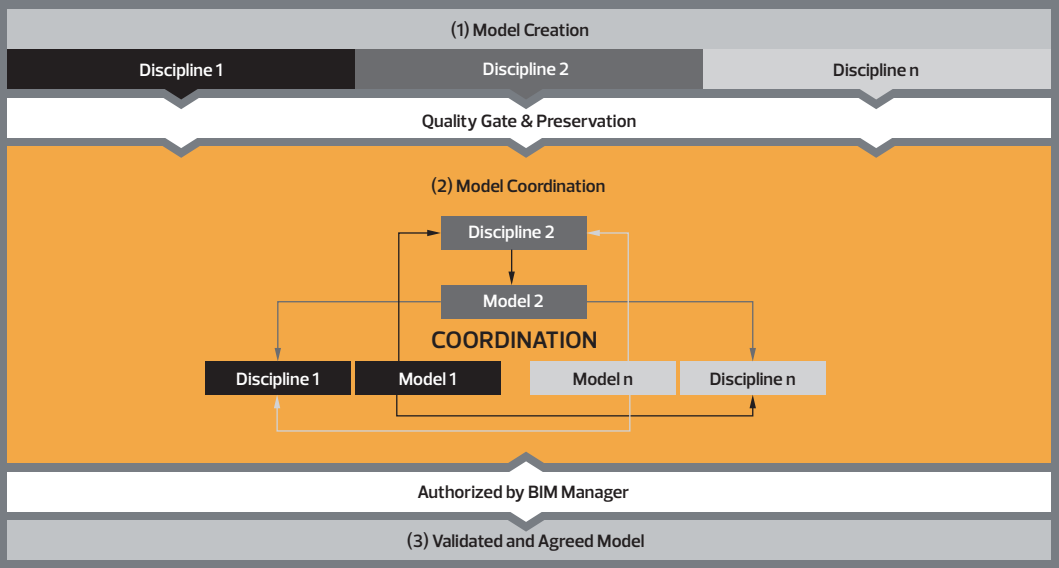

FIGURE 1:

Schematic BIM-based creation, coordination, and collaboration process; derived from BCA Singapore (2013)

BIM-BASED COLLABORATION PROCESSES

Model-based collaboration

Pre-requisite for a model-based collaboration is a comprehensive digital picture of the construction project. This representation arises from the collaboration of all project participants, who create or modify models or model contents using a range of BIM-enabled software products. There is wide recognition that the use of a single central model is not practical for a variety of reasons. For instance, individual processing areas of different disciplines can overlap, which means no clear allocation of responsibilities within the project is possible. In addition, the project participants generally have no interest in sharing all the information of their model, or intermediate status, with the other parties concerned on account of contractual arrangements. Hence, diverse guidelines, such as the Singapore BIM- Guide or the British Publicly Available Specification (PAS) 1192, take a discipline-oriented approach. This "Federated Model" approach states that every author, in accordance with their discipline, is responsible for their own digital model and shall have access for this model content only. Consequently, such a model only describes the subset of the entire model pertaining to the relevant discipline and is thus described as discipline model, submodel or technical model. Since the resulting individual discipline models are created and managed exclusively by the assigned authors, the responsibilities for individual components and corresponding changes can be organized clearly during the entire construction project.

- **Pre-requisite for a model-based collaboration is a comprehensive digital picture of the construction project.**
- **The use of a single central model is not practical.**
- **"Federated Model" approach: Every author, in accordance with their discipline, is responsible for their own digital model and shall have access as is relevant to their project role for this model content only.**
- **Via the clear allocation of the authors to individual discipline models the responsibilities for individual components and corresponding changes can be organized clearly during the entire construction project.**

In order to safeguard the integrity and consistency of the entire model the technical models must be checked at regular intervals for any inconsistencies or collisions. To this end, the approach provides a coordination environment in which the responsible project manager (generally the BIM manager) can check the consistency of at least two technical models. Here, the contents of these models are summarized in a coordination model and then checked for completeness (e.g., missing attributes), redundancy (e.g., double attributes) or inconsistency (e.g., conflicting information).

> **Potential inconsistencies or collisions between the discipline models must be checked at regular intervals in a coordination environment.**

In principle, every model author is personally responsible for the correctness of the model contents. Nevertheless, errors in individual technical models can be identified and intercepted early if a corresponding quality barrier is set up for the individual models at the point of entry to the coordination environment. One example of this kind of barrier might be a review of the agreed modeling guidelines or the agreed model content for a specific project milestone. Accordingly, a technical model must first of all fulfil the fundamental quality criteria before it can be reviewed in a coordination model with other models.

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THE COMMON DATA ENVIRONMENT

As already demonstrated, the organization and management of digital information and associated processes constitutes the principle task during the entire BIM-based construction project. In the past few years a lot of software solutions have been introduced which provide technical support for this task. Many of these products focus on the implementation of digital platforms on which the individual technical models can be managed and coordinated or corresponding processes depicted.

> **The organization and management of digital information and associated processes constitutes the principle task during the entire BIM-based construction project.**

At this point the PAS 1192 is introducing a technical specification for the technical and process-related implementation of such a platform: the Common Data Environment. In general, the CDE represents a central digital data room suitable for gathering, managing, evaluating and sharing information.

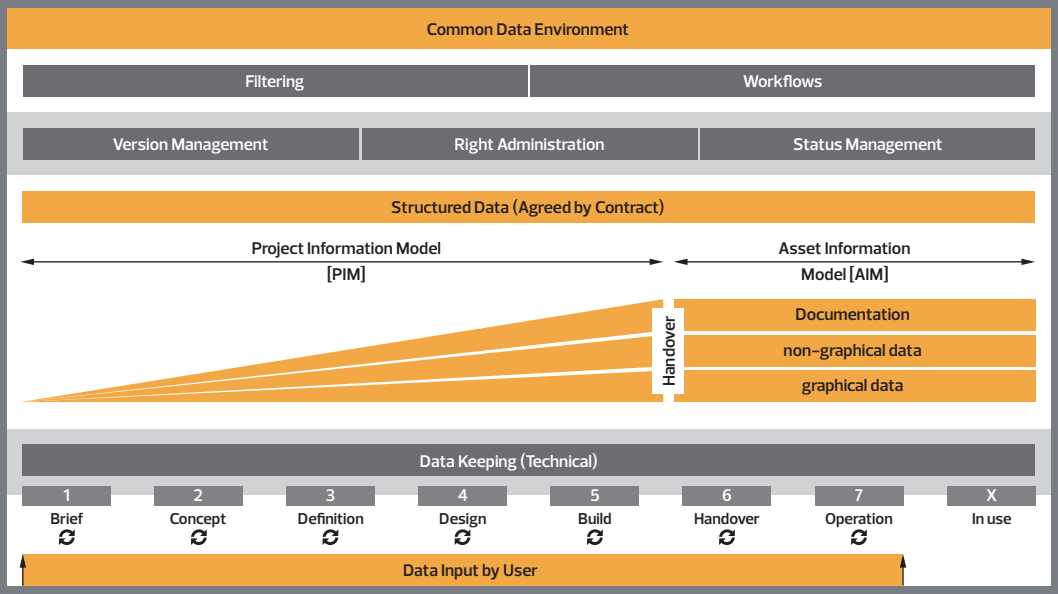

FIGURE 2:

Diagram showing the CDE, derived from the British Standards Institution (2014)

All project participants obtain the necessary information from the CDE and subsequently make available there new or modified information. Here, the approach of the discipline-oriented working method is applied. A key feature of the CDE is that all structured information to which a participant has access in accordance with their access rights is accessible at all times. At the same time, the CDE provides a platform for implementation of all necessary coordination and communication processes. This enables a complete BIM process to be depicted using the CDE.

- **The CDE represents a central digital data room suitable for gathering, managing, evaluating and sharing information.**
- **Using the CDE a complete BIM process can be depicted.**

Furthermore, the common digital data room entails key benefits: The centralization of the stored data within the CDE reduces the risk of redundancies and simultaneously ensures that all data is always up-to-date and available for all project participants. In addition, the CDE results in a higher reuse rate, simplifies the aggregation of model information and at the same time serves as the central platform for archiving and documentation.

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THE BIM INTEGRATION FRAMEWORK

Methodology – What the BIF does

Interoperability within a construction project remains a major challenge in the present BIM-based construction projects despite new approaches such as the CDE. These projects generally feature a range of different software products. Ultimately, it should be a matter for every participant, irrespective of the requirements for information exchange, to use the software best suited to their technical discipline for the particular area of responsibility. This leads to the classic interoperability issues, despite existing data standards for building and construction. Therefore, it ought to be the goal when implementing the model-based collaboration based on a CDE to make access to contents for users as simple and direct as possible.

- **Interoperability within a construction project remains a major challenge in the present BIM-based construction projects despite new approaches such as the CDE.**
- **It ought to be the goal of an implementation of the model-based collaboration based on a CDE to make access to contents for users as simple and direct as possible.**

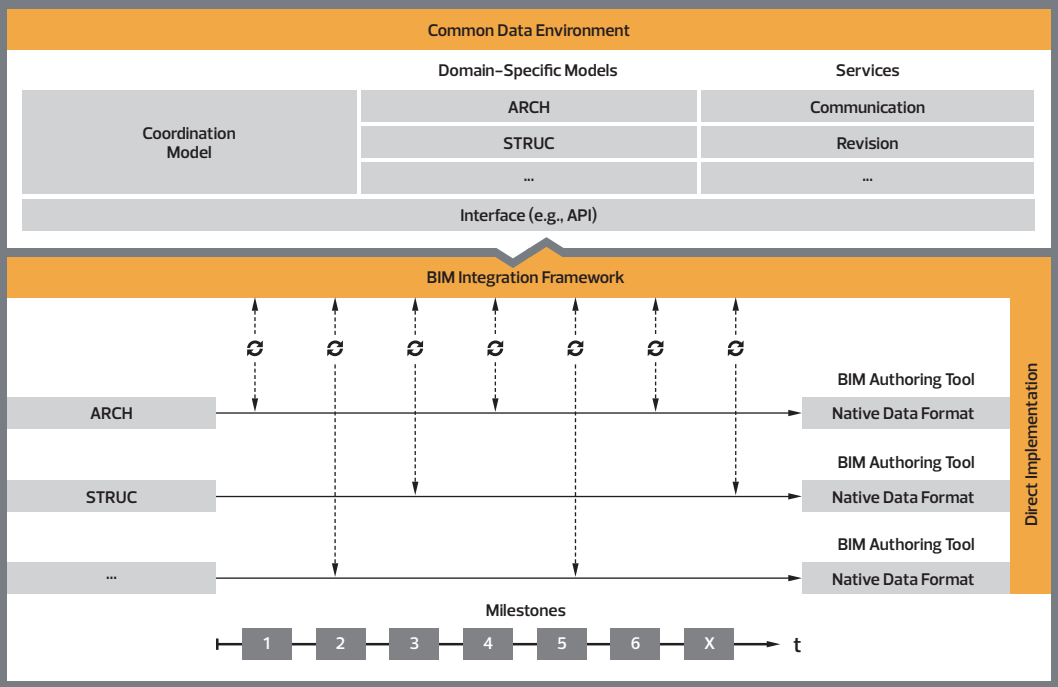

FIGURE 3:

Diagram showing the collaborative processes based on the BIM Integration Framework

For implementation of this collaboration using a CDE the requirements pertaining to the collaboration processes must be paired with the technical criteria already described. In addition, it should be noted that ultimately the users are able to carry out the defined processes with the resources available. In response to these challenges the BIM Integration Framework (BIF) was developed.

The BIF represents fundamentally a software concept which – provided certain basic conditions have been met – can establish the link from any BIM tool to a CDE. The principle task of this framework is to provide seamless integration of access to all functionalities of the CDE and to make these available directly in the particular BIM software. From a technical point of view, the BIF assembles all functions of the interface (API) of a CDE in a library. If the BIF is now integrated into a software product the users have at their disposal these functions and consequently a standardized link to the CDE. What is more, these functions are simultaneously standardized regardless of the BIM tool used, which guarantees that information is always displayed immediately for instance. Here, in particular the functions are paramount which serve to enable smooth collaboration, e.g., information exchange, process management or communication. In this way, the work and complexity of the current standard processes can be substantially reduced using the BIF. At the same time, all desired content can be retrieved and visualized if required which enables improved understanding for the processes and also for the processed information.

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- **The BIF assembles all functions of the interface (API) of a CDE in a library.**

THE CDE: ALLPLAN BIMPLUS

bim+ has been providing a commercial, open BIM platform since 2013. Since 2015 it has been part of ALLPLAN GmbH. The API functionalities form the core of the platform and provide full and transparent access to every individual piece of saved information and every defined process. Alongside fundamental functions such as creating, modifying and exchanging models and model contents, bim+ also offers enhanced functionalities, such as for example versioning of models, communication within a project or depiction of processes. Using the Task Board in bim+ the defined tasks can be defined quickly and clearly with all planning partners. bim+, therefore, meets all the basic requirements to be able to be used as CDE.

Since it concerns a RESTful API in terms of the bim+ programming interface, the functions can be used technologically neutrally, i.e., with any programming language. This technological neutrality guarantees that diverse software products can be linked irrespective of the used programming languages and programming environments.

> **bim+ is technologically neutral: Based on the RESTful API the functions can be used with any programming language.**

For structuring all information bim+ offers a proprietary data model which provides proper documentation and is closely linked with the class schematic of IFC. Moreover, the bim+ platform provides a web-based programming package which can be used, amongst other things, for displaying contents, such as for example geometry, alphanumerical information or managing projects, teams, users, user rights, models or revisions. The platform can continue to perform any routines from the server which reduces the capacity required on the part of the local access device. In summary, it can be concluded that bim+ fulfils the fundamental requirements of a CDE with its open structure and accessibility and also those for implementation of the BIF and certainly, therefore, is suitable as the basis for the proof of concept of the BIF.

PROOF OF CONCEPT – IMPLEMENTATION OF THE BIF

As proof of concept the BIF was implemented as a prototype based on bim+. At present the BIF is available as .NET- and Java library. Since many of the currently available BIM tools are based on these technologies the BIF can be integrated directly into these products – provided that the product in question permits such an integration technically. Due to the technological neutrality of the API the BIF can also be implemented in other programming languages and programming environments (e.g., Python). In addition, the architecture of the BIF allows a dynamic extension with plug-ins, which in turn can be used universally in all integrated environments. Amongst other things, the user interfaces have been integrated for visualization of bim+ contents using the Web programming package. These WebControls can be integrated directly into the interfaces of the connected software, flexibly and as you wish.

> **The BIF can be integrated directly in .NET- or Java-based BIM tools.**

> **The architecture of the BIF allows a dynamic extension with plug-ins, which can be used universally in all integrated environments.**

A first prototype of the BIF has been successfully integrated in various applications. Consequently, there are integrations for the following products, amongst others: Allplan 2017, Autodesk Revit 2016, Tekla Structures and Scia Engineer.

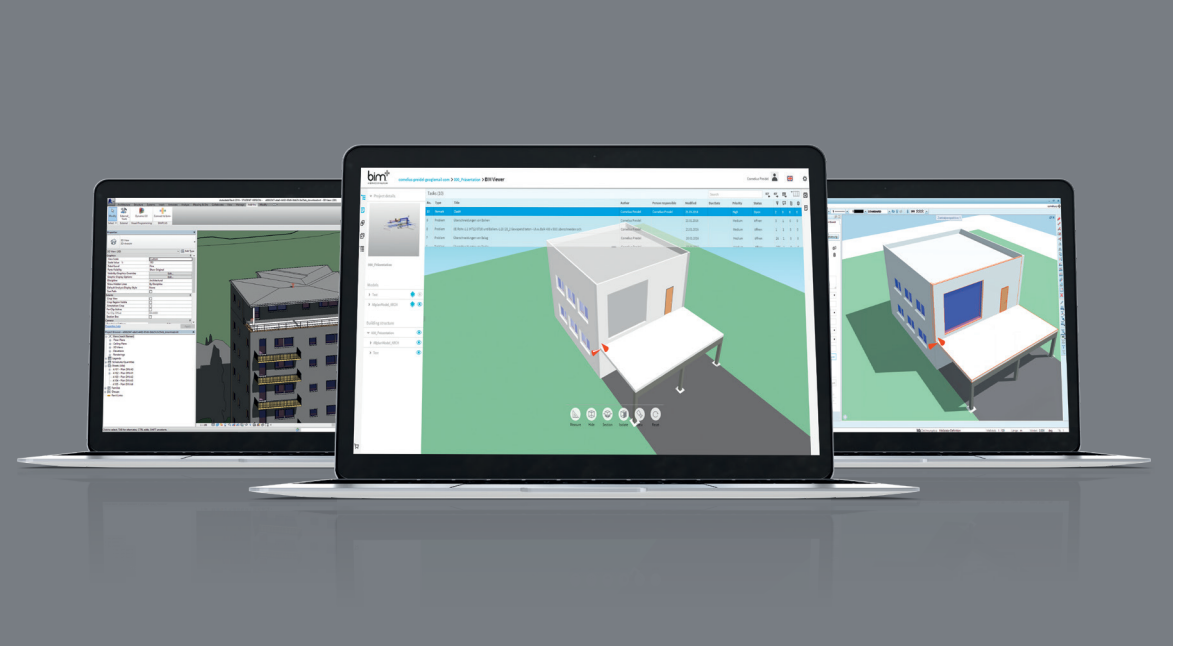


FIGURE 4:

BCF-based communication via the BIF. Display of the same "Topic" object in the web interface of bim+ (left) and Allplan 2017 (centre) and Revit 2016 (right)

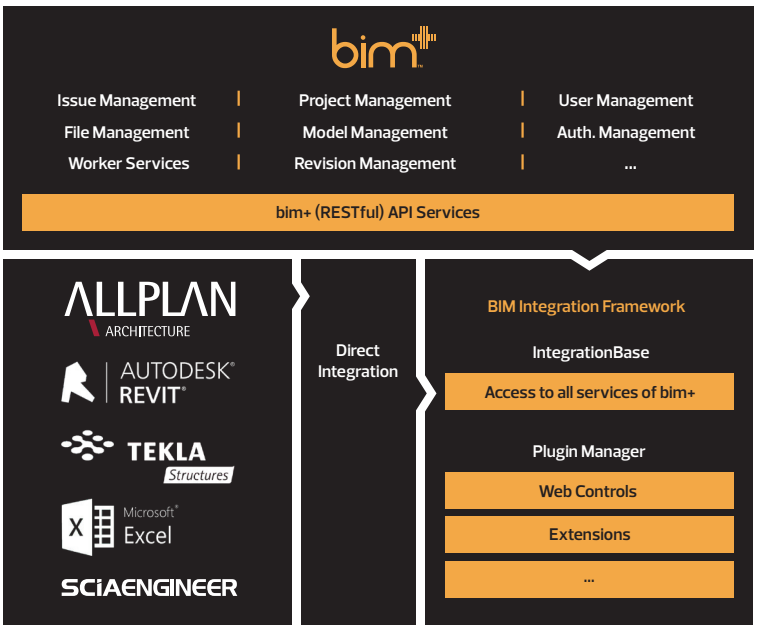
NOT WITHOUT EXCEL – CONNECTION OF NON-BIM-ENABLED PRODUCTS

Via the BIF it is also possible to connect non-BIM-enabled products which are, however, applied across building and construction. These include, for example, spreadsheet program Microsoft Excel, which is used for various tasks in the different disciplines. In order to demonstrate the potential and flexibility of the BIF, an integration for Excel was also implemented and so made accessible the individual functions within the program. This way within the Excel interface the user can be suitably connected with bim+ and if required have the information displayed as tables. Since in Excel no visualization of three-dimensional contents is supported, the connection to the 3D-WebControl was established here via the BIF, which alternatively can be used for visualization within Excel. As a result a component selected in Excel can be automatically chosen in the 3D-WebControl and displayed with other detailed information.

› **Also non-BIM-enabled products can be connected with the CDE and used for displaying and evaluating digital building information.**

FIGURE 5:

Software architecture of the BIF based on bim+



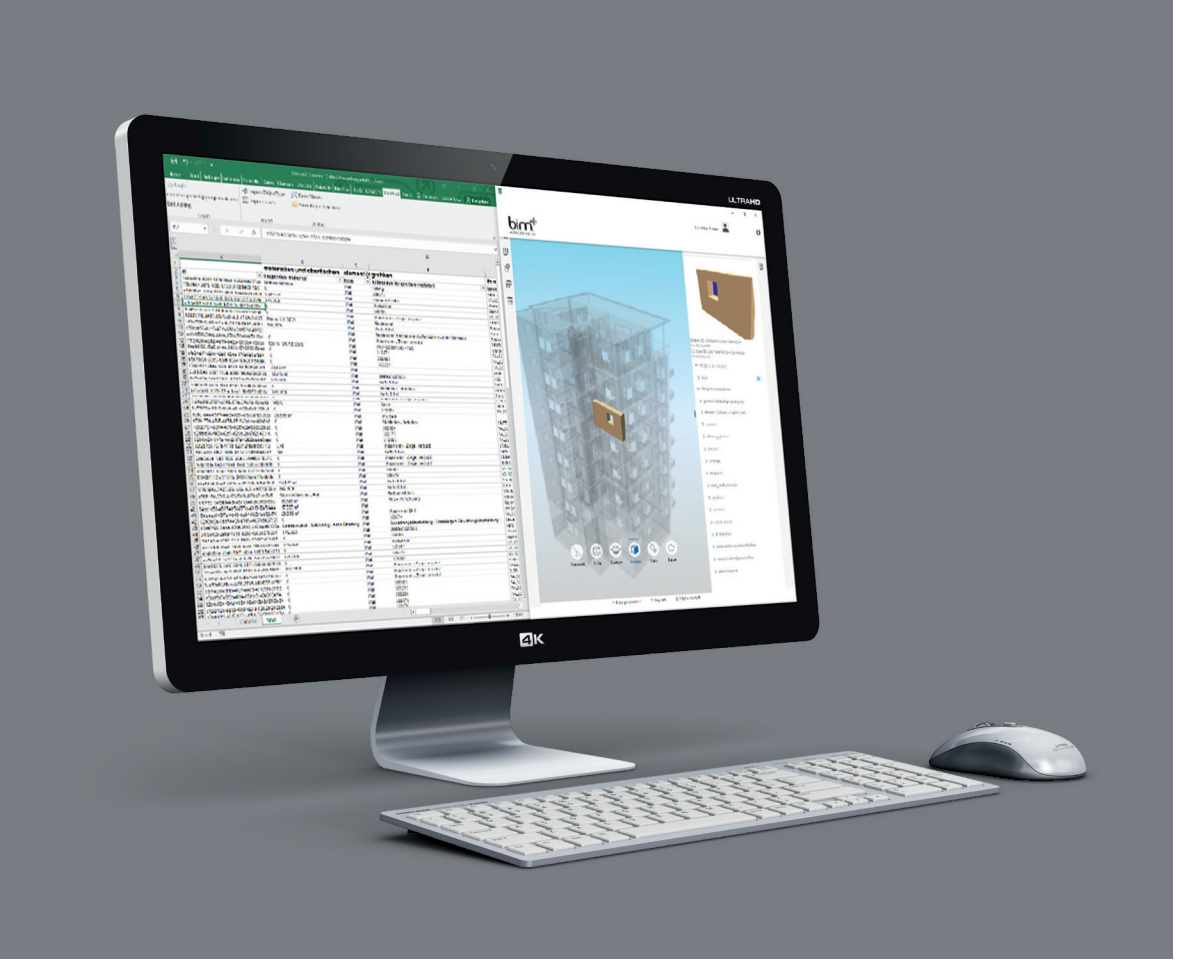


FIGURE 6:

Integration of the BIF functions in Microsoft Excel

GOING FORWARD

The presented applications of the BIF demonstrate the potential of the concept. The functions of the CDE will be made available to users within their own desktop environment, giving them a better understanding. Using the BIF it should be possible for users to view current information and workflows and if necessary intervene. The presented principle of the BIF can be extended to any other products as long as the defined basic requirements are met. An expansion of the BIF to other software products and an extension of the functionalities it incorporates is planned for the future.

> **The principle of the BIF can be extended to any other products that are presently under development.**

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ABOUT THE COMPANY

ALLPLAN is a leading European vendor of open solutions for BIM (Building Information Modeling). For more than 50 years, the company has supported the AECOM industry with a pioneering software portfolio and is playing a key role in promoting the digitalization of the building industry: innovative, geared to the requirements of customers – and with best quality "Made in Germany".

ALLPLAN GmbH
Konrad-Zuse-Platz 1
81829 Munich
Germany
info@allplan.com
allplan.com/contact